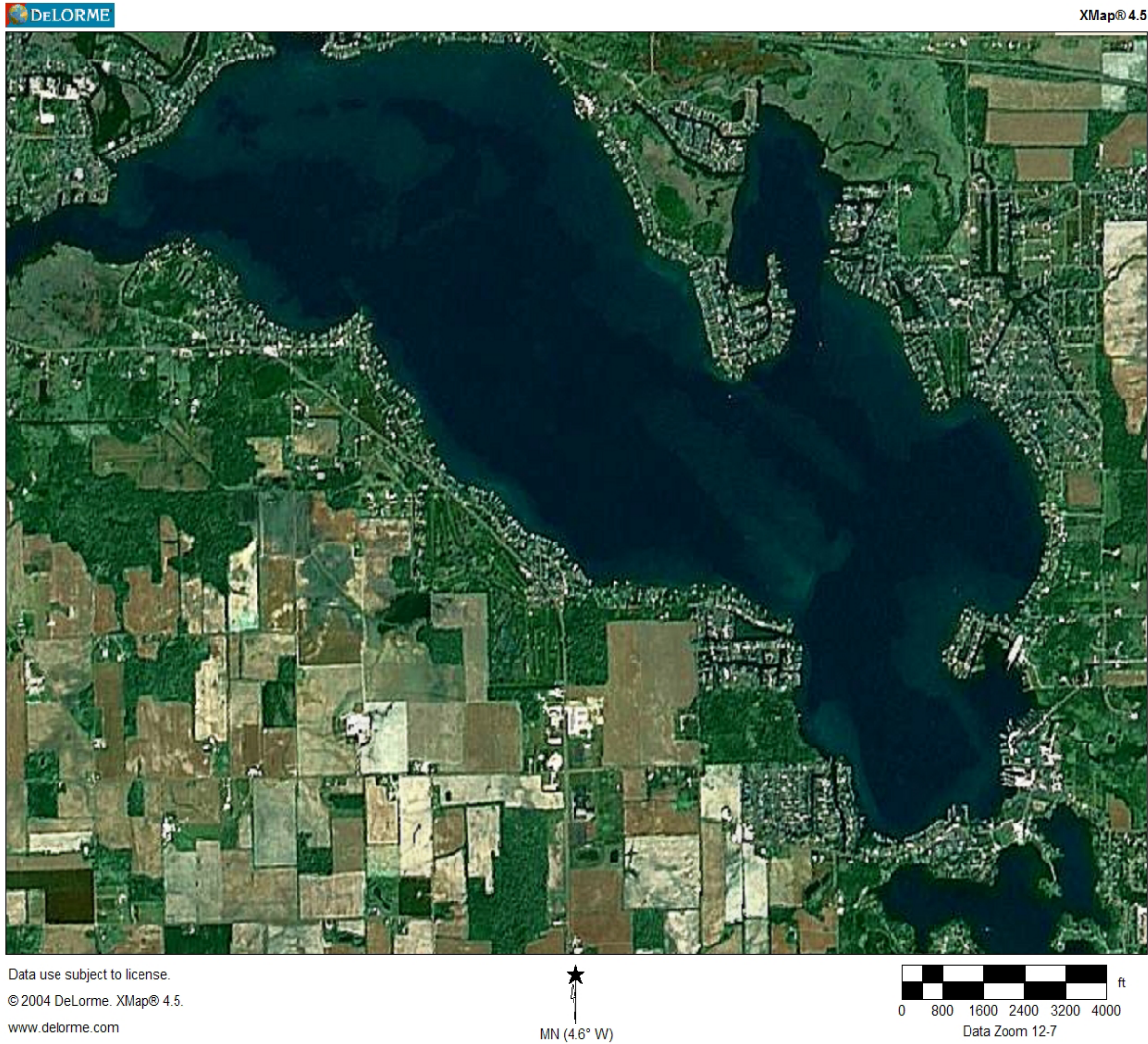


# Lake Wawasee Aquatic Vegetation Management Plan



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## Executive Summary

The following report outlines a long-term vegetation management strategy for Lake Wawasee. Aquatic Weed Control was contracted by the Wawasee Area Conservancy Foundation to conduct aquatic vegetation surveys and propose a lake management plan based on the results of the surveys. Funding for this plan was provided by the Wawasee Area Conservancy Foundation and the Indiana Department of Natural Resources (IDNR) through the Lake and River Enhancement (LARE) program.

In 2005, Aquatic Weed Control conducted two aquatic vegetation surveys to characterize the plant community of Lake Wawasee. An early season survey was conducted on May 26, 2005, and a late season survey was conducted on August 10, 2005. Each survey followed protocol established by the IDNR, and consisted of a Tier I reconnaissance survey and a Tier II qualitative survey. The Tier I survey is designed to give an overview of the plant structure in the lake, while the Tier II survey describes individual species distributions and abundances in more detail.

Based on the results of these surveys, a management plan was constructed to help reach the three major management goals established by the IDNR for all public lakes in Indiana, including those applying for LARE funding. These three goals are listed below.

1. Develop or maintain a stable, diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality and is resistant to minor habitat disturbances and invasive species.
2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.
3. Provide reasonable public recreational access while minimizing the negative impacts on plant and wildlife resources.

The 2005 vegetation surveys of Lake Wawasee found a diverse plant community. The majority of these plants are native species that are beneficial to Lake Wawasee's ecosystem. These species should remain in the lake and should be protected to maintain biodiversity. Two invasive plant species, Eurasian watermilfoil (*Myriophyllum spicatum*) and curly leaf pondweed (*Potamogeton crispus*) were also present in the 2005 surveys. Eurasian watermilfoil is of special concern, as it was found throughout the entire lake. Although this plant is widely distributed, its overall dominance in the lake is fairly low. There are some areas where Eurasian watermilfoil dominance is particularly heavy, and these areas will be surveyed in the years to come. If Eurasian watermilfoil continues to increase in these areas, they should be chemically treated to reduce the milfoil population. If the Eurasian watermilfoil dominance does not increase in these areas, no chemical treatment may be necessary.

## Early season aquatic vegetation survey

Any herbicide applications will depend on the results of the surveys.

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## **Acknowledgements**

Aquatic vegetation surveys conducted on Lake Wawasee were made possible by funding from the Wawasee Area Conservancy Foundation and the Indiana Department of Natural Resources. Aquatic Weed Control would like to extend special thanks to Indiana Department of Natural Resources (IDNR) District 3 biologist Jed Pearson for providing procedural training for both Tier I and Tier II aquatic vegetation surveys. Cecil Rich, aquatic biologist for the IDNR Division of Fish and Wildlife provided valuable consultation regarding the requirements and objectives of this lake management plan. Brad Fink, assistant fisheries biologist, also provided assistance and training for data analysis computer programs. Jim Donahoe and David Keister of Aquatic Weed Control performed the aquatic vegetation sampling and are the authors of this report. Aquatic Weed Control would also like to thank the members of the Wawasee Area Conservancy Foundation for their commitment to improving this lake and for valuable discussion and input brought forward at the informational meeting held on December 6, 2005.



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## **1.0 Introduction**

Aquatic Weed Control was contracted by the Wawasee Area Conservancy Foundation to develop a long-term lake-wide management plan. Funding for this report was provided by the Wawasee Area Conservancy Foundation and the Department of Natural Resources. This funding was part of the Lake and River Enhancement (LARE) program.

When a person registers a boat within the state of Indiana a lake enhancement fee is included in the cost of registry. One third of this money is then used to provide funding for projects designed to improve the quality of Indiana lakes by controlling invasive plant species.

The surveys included in this report, as well as the management plan, are required by the state to receive funding to treat the lake for exotic aquatic vegetation. Should a lake be selected for LARE funding, up to 100,000 dollars can be awarded for a whole-lake treatment. Up to 20,000 dollars can be awarded annually for 3 consecutive years to treat areas of regrowth. If the whole lake is not treated, up to 20,000 dollars can be available annually for up to three years for spot treatments of invasive species. Requests for funding are reviewed by the LARE office, and funds will be distributed at the discretion of the director of the IDNR.

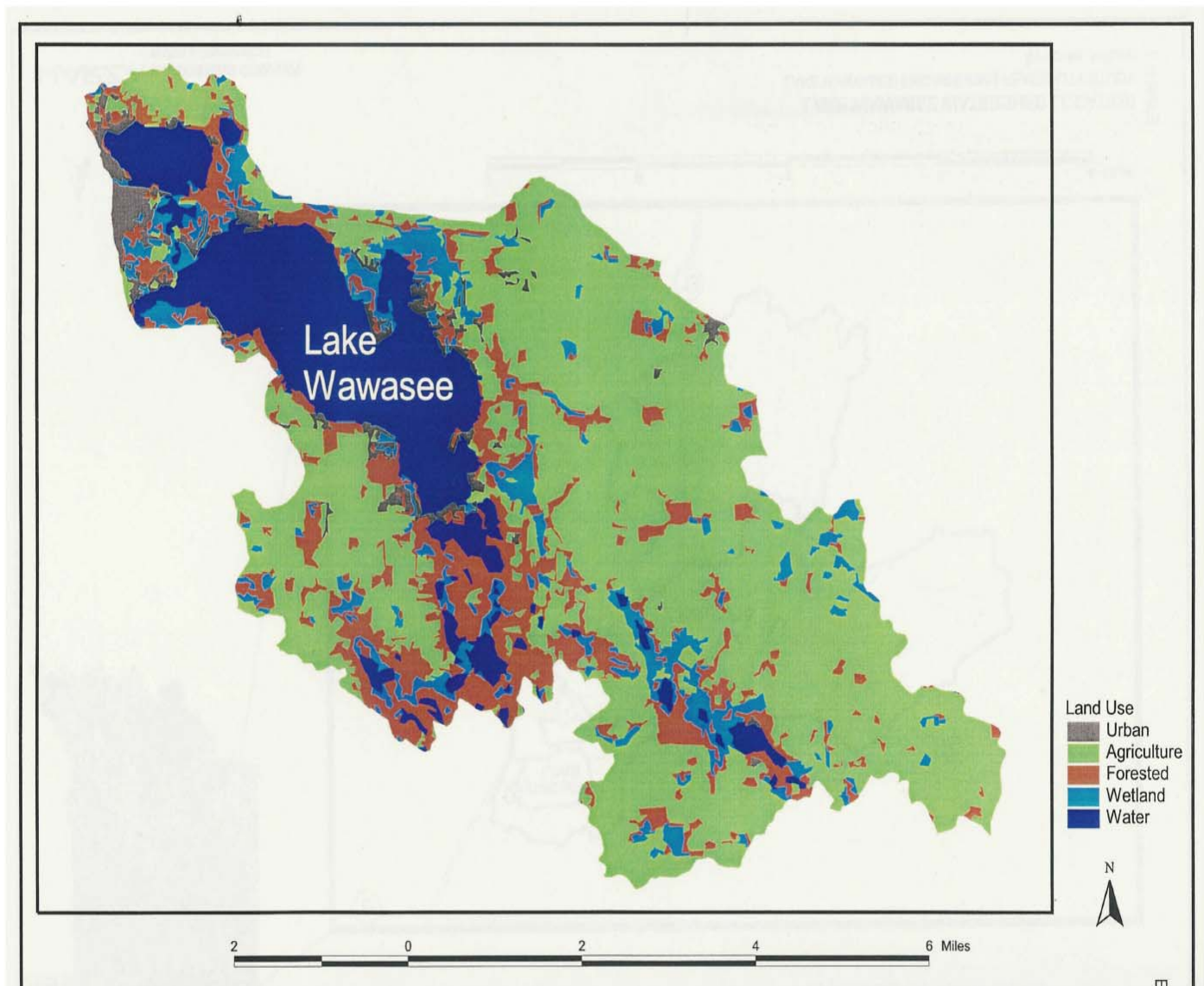
This project was initiated to take develop a basis for evaluating the health of the Lake Wawasee plant community and the distribution and abundance of Eurasian watermilfoil. Eurasian watermilfoil grows in the large plant beds that are located near the deep edge of the littoral zone in many areas of the lake. The proposed action plan outlined in this report should provide the information needed to ensure that the native plant community is protected, and that the Eurasian watermilfoil population is kept under control.

## **2.0 Watershed and Lake Characteristics**

Lake Wawasee, located in northeastern Kosciusko County, has 3060 surface acres with a maximum depth of 77 feet and an average depth of 22 feet (Tyllia, 2000). A diagnostic and feasibility study sponsored by the Wawasee Area Conservancy Foundation was completed by Commonwealth Engineers Inc. in 1996, and an engineering feasibility study was completed by Harza Engineering Company in May of 2001. These studies published very detailed information about the watershed of Lake Wawasee.

According to Harza Engineering's 2001 study, Lake Wawasee drains approximately 24,450 acres. Lake Wawasee has a watershed area to lake area ratio of 8:1, which is very low when compared to other lakes in the area. This low ratio helps to limit the amount of nutrients flowing into the lake, and is most likely a factor in the relatively high water quality found in Lake Wawasee. The flushing rate of Lake Wawasee was calculated by Purdue University researchers, and found to be 3.4 years. This is a relatively long flushing period when compared with many area lakes. The following picture was generated by Harza Engineering to describe the Lake Wawasee watershed.

Figure 1: Wawasee Watershed (adapted from Harza, 2005)



The majority of the land in the watershed (51%) is used for agricultural purposes. Also, approximately 90 percent of the shoreline of Lake Wawasee is developed, making residential and agricultural uses the primary source of nutrient loading for Lake Wawasee. Thirteen percent of the watershed is used for pasture, while 16 percent of the watershed is forested.

The Tri-County Fish and Wildlife Area is a major asset to the watershed of Lake Wawasee. This area is located directly to the south of the IDNR's public access site. This area was established in 1951 and holds 3,486 acres of land that is protected from both development and agriculture. This area includes 10 natural lakes, and 32 man-made impoundments with 650 acres of water. It also holds approximately 200 acres of restored open water wetlands, in addition to numerous marshes and swamps. These wetland areas are extremely important for water filtration and are undoubtedly a significant factor in maintaining high water quality in Lake Wawasee.

**Table 1: Watershed Land Use (adapted from Harza, 2005)**

<b>Land Use</b>	<b>Acres</b>	<b>Percentage of Watershed</b>
Urban	785	3%
Agricultural	12,415	51%
Pasture	3,220	13%
Forest/ Woodland	3,975	16%
Water	4,055	17%

Water quality is considered relatively good in Lake Wawasee when compared to many Indiana lakes. Secchi disk readings are usually between 10 and 15 feet. Water clarity has increased in recent years due to the accidental introduction of zebra mussels. The bottom is a mix of mud, sand, gravel, and marl. Aquatic plant growth is sparse in many shallow areas of the lake. Areas shallower than 4 feet typically are sparsely populated with chara being the dominant species.

Vegetative growth in these areas may be inhibited by wave action, boating traffic, and bottom composition. Dense weed beds form throughout the lake in 8 to 25 feet of water. Large wetland areas are located in Conklin Bay and Johnson's Bay totaling approximately 240 acres. These wetlands are of special concern since very few wetland areas remain on Lake Wawasee. The IDNR has established idle speed zones around the perimeter of these wetlands to help reduce the disturbance of these areas.

Lake morphometry is fairly unique when compared to many area lakes. Extensive shallow "shelves" nearly ring the entire shoreline of the lake. These shelves slope gradually from shore to a water depth of about 12 feet. At this depth, the majority of these shelves drop very sharply into at least 30 feet of water. The lake also contains numerous sand bars and mid-lake rises that make Lake Wawasee's morphometry significantly more complex than many area lakes.

### **3.0 Lake Uses**

Lake Wawasee is the largest natural lake in Indiana and is highly valued to many stakeholders for a number of reasons. The lake has a large expanse of open water, has no speed limit, has a public access site, its shoreline is almost completely developed, and it has an excellent fishery. These characteristics make it very attractive to multiple forms of recreation, and make it very important to the local economy.

Both inboard and outboard motors are allowed, and there is no speed limit during daylight hours (a 10 mph speed limit is enforced after sunset). This makes Lake Wawasee very popular with water skiers, jet skiers, and boaters. All open water portions of Lake Wawasee are used for boating, tubing, and water skiing. Multiple yacht clubs increase access to the lake and make it a very popular place for sailboats as well.

In addition to these activities, Lake Wawasee has an excellent fishery. It harbors many healthy populations of popular game fish such as largemouth bass, northern pike, bluegills, crappies, and yellow perch. This lake is especially popular with many largemouth bass, northern pike, and bluegill anglers. Popular fishing spots include Johnson's bay and Conklin Bay, as well as the numerous deep weed lines and mid-lake rises that are found throughout the lake. Bluegills are often found suspended in deep



water during the summer and are very popular with local anglers. Crappies are often found in channels and shallow flats in spring, and often suspend in open water during the summer.

The size of Lake Wawasee also makes it very attractive to bass tournament anglers. Numerous bass clubs from in and out of state areas hold tournaments on the lake, both during daylight hours and after dark as well.

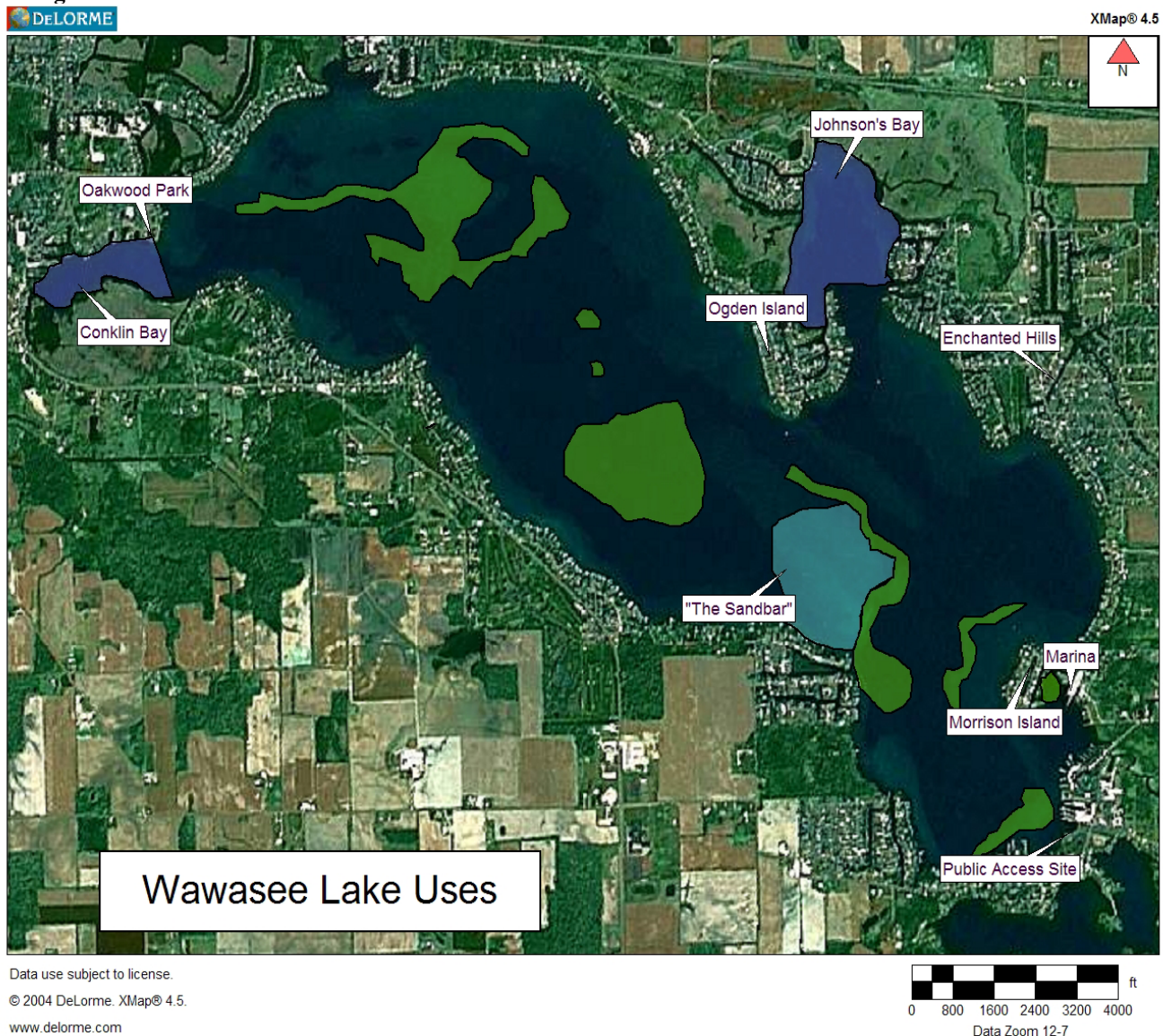
The public access site for Lake Wawasee is located at the south end of the lake near the intersection of County Road 1000N and Turkey Creek Road. This site is handicapped accessible and has parking for 100 vehicles and boat trailers (Tyllia, 2000). The parking lot of the public access is often nearly filled, especially on summer weekends.

Any management practices implemented on this lake will benefit both the lake residents and a large number of stakeholders who visit the lake on a regular basis. The size, location, accessibility, and utility of Lake Wawasee make it an increasingly popular lake for recreational use and one of the most highly valued lakes in the state.

The Sandbar” is outlined in light blue and is an extremely popular spot for pleasure boaters during the summer. The bottom substrate is very sandy and aquatic vegetation is sparse, making it a popular place to anchor boats and go wading or swimming. The public access site is labeled at the south end of the lake, and Johnson’s and Conklin bays are outlined in dark blue.

Figure 2 describes lake uses on Wawasee. Heavy boating traffic occurs throughout the entire lake. Some popular fishing spots (deep weed lines, mid-lake rises and deep mud flats) are outlined in green.

Figure 2: Wawasee Lake Uses



## 4.0 Fisheries

Five fisheries surveys have been conducted on Lake Wawasee. These surveys have taken place in July 1975, July 1985, July 1997 and July 2004. The most recent fisheries survey (July 12-16, 2005) used electro-fishing, gill nets, and trap nets to collect 2822 fish with a total weight of 607.99 pounds. Twenty-eight species of fish were collected, with bluegills being the most abundant fish by number (68%) and the second most abundant fish by weight (17% of the total weight). Largemouth bass ranked second in number and fourth in weight (15.85), while yellow bullhead ranked third in number (115) and third in weight (16.2%). Northern pike ranked eleventh in number (37) but second in weight (19.55). Yellow perch, redear sunfish, and black crappies were ranked fourth, fifth, and sixth in number respectively (IDNR 2004 and 2005).

Major trends in the fisheries survey data were outlined in the most recent fisheries survey. Bluegill abundance has increased since these surveys began, and is now at its

highest point ever. However, the abundance of large bluegills has declined and growth rates have slowed as numbers have increased. Only 14 of the 1,919 bluegills collected in the survey were 7 inches or larger. Mean length of age 6 bluegills dropped from 8.8 inches in 1997 to 7.6 inches in 2004 (IDNR 2004 and 2005).

Largemouth bass populations are steady, while the number of large bass collected is at its highest point ever. The percentage of 12 inch largemouth bass increased from 33% in 1997 to 42% in 2004. Two percent of the bass collected were 18 inches long, which is higher than all previous surveys as well. Electrofishing catch rates of largemouth bass increased from 26 fish per hour in 1985 to 40 fish per hour in 1997 to 41 fish per hour in 2004. Factors influencing the greater abundance of larger bass may be the 12 in minimum size limit placed on largemouth bass in 1991. This minimum size limit was increased to 14 inches in 1998.

The increasing popularity of catch and release practices for many sportfish may also be helping the bass population to thrive. It is also important to note that the lake also holds fair numbers of smallmouth bass, as well as a large population of good sized northern pike. Both of these species are very popular with sport fisherman as well.

Yellow perch numbers remained steady in the 2004 survey. Although they were replaced by yellow bullhead as the third most abundant fish species, it was noted that this was due to an increase in the yellow bullhead population, and not a decrease in the yellow perch population. The following chart was compiled by Brad Fink, assistant District 3 fisheries biologist. It summarizes the results of the July 2004 fisheries survey.

**Table 2: Wawasee Fisheries Survey (adapted from IDNR 2004)**

Relative Abundance, Size and Estimated Weight of Fish Collected at Lake Wawasee						
Common Name*	Number	Percent	Minimum	Maximum	Weight (lb)**	Percent
			Length (in)	Length (in)		
Bluegill	1919	68.00	1.8	9.1	103.30	16.99
Largemouth bass	142	5.03	1.5	18.7	95.88	15.77
Yellow bullhead	115	4.08	6.3	14.7	98.53	16.21
Yellow perch	95	3.37	1.8	12.9	17.47	2.87
Redear sunfish	94	3.33	2.5	11.0	18.86	3.10
Black crappie	65	2.30	3.8	13.8	11.01	1.81
Longear sunfish	59	2.09	2.0	5.2	2.27	0.37
Brook silverside	47	1.67	2.9	3.8	NA	NA
Rock bass	40	1.42	2.3	11.3	9.01	1.48
Logperch	37	1.31	2.7	4.6	NA	NA
Northern pike	37	1.31	17.9	34.7	118.72	19.53
Bluntnose minnow	36	1.28	1.6	3.4	NA	NA
Warmouth	32	1.13	2.3	8.0	6.36	1.05
Pumpkinseed sunfish	21	0.74	3.0	7.9	2.98	0.49
Spotted gar	15	0.53	14.1	27.2	18.42	3.03
Brown bullhead	13	0.46	7.3	14.8	17.80	2.93
Golden shiner	13	0.46	4.3	7.3	0.69	0.11
Bowfin	8	0.28	17.0	27.5	30.75	5.06
Carp	7	0.25	10.8	30.4	37.35	6.14
Smallmouth bass	6	0.21	1.9	15.7	6.42	1.06
Lake chubsucker	5	0.18	7.2	8.7	1.25	0.21
Hybrid sunfish	5	0.18	4.7	7.5	1.23	0.20
White bass	3	0.11	12.9	13.5	3.24	0.53
Grass pickerel	3	0.11	6.5	7.6	0.26	0.04
Mimic shiner	2	0.07	2.1	2.4	NA	NA
Central mud minnow	1	0.04	3.9	3.9	NA	NA
Channel catfish	1	0.04	25.7	25.7	5.75	0.95
Longnose gar***	1	0.04	18.7	18.7	0.44	0.07
Total	Number	2822		Weight	607.99	
*Common names of fishes recognized by the American Fisheries Society.						
**Weights estimated from standard length-weight regression models.						
***Several spotted gar and additional longnose gar were collected in gill nets but the data sheet was lost						

Since aquatic plants and fisheries health are so closely related, it is important to evaluate how changes in the plant community may impact the fishery of Lake Wawasee. Aquatic plants provide ambush cover for predators, as well as protective cover for young fish. This fisheries survey made direct comparisons of sampling success between natural shoreline areas and artificial shoreline areas (bulkhead seawalls etc.). Natural shoreline areas produced a catch rate of 1154 fish per hour, while bulkhead seawalls produced a catch rate of 242 fish per hour. This significant difference in fish abundance reinforces the importance of protecting the remaining natural shoreline and wetland areas of Lake Wawasee.

Optimal aquatic plant coverage for fish varies between species but is generally considered to be between 20% to 40% of the lake's total surface area. One notable exception is northern pike, which may prefer that 80% of the lake be covered with SAV (IDNR 2005). Recent scientific studies have shown that fish communities are adversely affected when submersed aquatic vegetation (SAV) falls below 10% of the total surface area, or increases to 60% of the total surface area. 2005 aquatic vegetation surveys estimated that weed beds covered 55% of Lake Wawasee's total surface area. However, 35% of these weed beds were sparsely covered with vegetation and provided only

marginal fish habitat. Very dense weed beds covered only 20% of the lake's surface area, so overall SAV cover appears to fall within the optimal percentages recommended for healthy ecosystems. The diverse fish community is further evidence that SAV coverage is at an appropriate level in the main lake (IDNR 2004 and 2005).

Lake morphometry is the factor that is most strongly correlated with SAV cover ratios. Assuming that ample amounts of phosphorus, nitrogen, and other nutrients are available, as well as a suitable substrate, SAV will be abundant. Just as important as the amount of fish habitat is the quality of fish habitat. In cases of exotic plant invasion, the most severe problems are often caused by a decline in habitat quality, even though the total amount of habitat may increase. This underscores the importance of monitoring the Eurasian watermilfoil population in Lake Wawasee. This will prevent Eurasian watermilfoil from degrading the high quality habitat provided by native plants.

## **5.0 Problem Statement**

Main causes for concern in Lake Wawasee are the presence of Eurasian watermilfoil in the lake, as well as the degradation of significant wetland areas along the shoreline of the lake, especially in Johnson's Bay and Conklin Bay.

Eurasian watermilfoil is found throughout Lake Wawasee in moderate abundance. Eurasian watermilfoil is of primary concern because of its aggressive nature and its destructive effects on lake ecosystems. This nuisance species grows and spreads rapidly, forming dense weed beds that rob native plants of the light and nutrients they need to survive.

In lakes where Eurasian watermilfoil is left unchecked, well-diversified plant communities can be decimated and replaced by a single species. Eurasian watermilfoil has the ability to overwinter, giving it a distinct growth advantage over many native plants. The milfoil lies dormant during the winter months instead of dying completely like many native plants. As spring arrives, the dormant milfoil plants have a head start on many native plants and reach the surface faster, shading out the natives. Eurasian watermilfoil grows profusely, provides poor fish habitat, inhibits boat navigation, and causes annoyances and even serious health hazards to skiers, swimmers, and other members of the public wishing to enjoy the lake.

The surveys conducted in 2005 will provide a way to monitor the abundance of Eurasian watermilfoil in Lake Wawasee. Over the past five years, many channels of the lake have been selectively treated with contact herbicides. These treatments have provided short-term relief from the milfoil, but do not impact the population of the main lake. All past chemical treatment on Lake Wawasee was conducted upon the requests of lake residents. All of these treatments were privately funded. The action plan outlined in this report should provide a basis for more effective long term control of Eurasian watermilfoil through evaluating its abundance, and if necessary, chemically treating areas of heavy infestation.

The wetland areas in Johnson's Bay are in need of intervention to prevent their further decline. Significant steps have already been taken by the IDNR to protect these areas. Idle speed zones surrounding these areas should help protect them from wave action and



other disturbances caused by heavy boating traffic. These areas should be monitored to evaluate the effects of the protective zones.

## 6.0 Vegetation Management goals and Objectives

The following management goals have been established by the IDNR for all lakes applying for LARE funding. Any management practices implemented on Lake Wawasee are to directly facilitate the achievement of these three goals:

1. Develop or maintain a stable, diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality and is resistant to minor habitat disturbances and invasive species.
2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.
3. Provide reasonable public recreational access while minimizing the negative impacts on plant and wildlife resources.

### Specific Objectives:

Specific objectives are needed to ensure that the fundamental goals of the LARE program are met. The following steps are recommended to help achieve LARE management goals for Lake Wawasee.

1. **Tier I and Tier II surveys should be conducted in each of the next two years to monitor the distribution and abundance of Eurasian watermilfoil, as well as the native plant community in Lake Wawasee.** Any changes in the plant community will be identified and survey results will provide the basis for future management strategies.
2. **If there are significant increases in the Eurasian watermilfoil population, the heaviest areas of infestation should be chemically treated.** The deep wedge lines at the south end of Lake Wawasee appeared to be the most heavily infested with Eurasian watermilfoil. If treatment is needed, it will likely be in this area. Data from this area will be separated from all of the other data to provide more site specific information about the Eurasian watermilfoil population in this area.
3. **The wetland areas in Johnson's Bay and Conklin Bay should be monitored to evaluate changes in the plant community due to the establishment of idle speed zones established by the IDNR.** Some research has already been conducted as to changes in the fish community in these areas (IDNR, 2005). More monitoring may be necessary and may be required in future LARE vegetation survey protocols.

## 7.0 Past Management Efforts

The District 3 fisheries offices were consulted to determine past plant management efforts on Lake Wawasee. Each area of the lake that has been chemically treated over the



past three years has a treatment report on file at the fisheries office. Based on these treatment reports, approximately 30 acres have been chemically treated to control submersed weeds and algae in each of the last three years. Nearly all of these treatments have taken place in the large channel systems adjacent to the lake. These treatments have been conducted using contact herbicides used to control both native and exotic species. While these treatments have successfully improved access for boating and fishing, they cannot be expected to control Eurasian watermilfoil in the open areas of Lake Wawasee.

Chemical treatment on the main lake area of Lake Wawasee is extremely limited. Very few individual lots on Lake Wawasee have been chemically treated. The estimated area of these small treatments is only about 3 acres, which is less than 1% of the lake's surface area. The lack of treatment on Lake Wawasee is reflective of its plant structure and morphology. Most near shore areas have only sparse vegetation, and most of this is chara, which does not interfere with recreational activities when found in low abundance. Channels are subject to less wave action, more nutrient rich runoff, and often have more organic matter in the sediment, making weed growth more abundant and making chemical control necessary.

## **8.0 Aquatic Plant Community Characterization**

All lake management plans submitted for LARE funding must be accompanied by lake-wide aquatic vegetation surveys. These surveys are used to ensure that the plant community of the entire lake is adequately characterized. They provide information about the overall structure of the plant community and describe species distribution and abundance in detail.

Two surveys per year are conducted on each lake. One survey is conducted in the spring and another is conducted later in the summer. This two-survey process is essential in providing an accurate representation of all plant species in a lake. Some species such as eel grass (*Vallisneria americana*) are not prevalent until summer and may be under-represented if only one survey was conducted in the spring. Other species such as curly-leaf pondweed (*Potamogeton crispus*) are prevalent in the spring and die off in the summer. This species would be under-represented if only one survey was conducted in the summer. Because of the diverse life cycles of different plants, multiple surveys increase the chance of accurately representing all of the species in a lake.

Tier I and Tier II survey protocols have been established by the IDNR to ensure that each lake is surveyed in the same manner. These surveys reduce subjectivity and provide a consistent basis for the evaluation of a lake's plant community from year to year, as well as a basis for comparing the plant communities of different lakes. They provide quantifiable results that are vital for monitoring the success of management programs. In short, these vegetation surveys are the foundation for describing an aquatic plant community and proposing an effective management strategy.

## 8.1 Methods

This section provides an overview of the purpose and procedures behind the Tier I and Tier II vegetation surveys. The common goal of these surveys is to accurately describe the aquatic plant community of any particular lake. Standard procedures are established to ensure that:

1. The same survey procedures are used for each lake applying for funding.
2. Subjectivity is kept to a minimum to maintain scientific integrity.
3. The sample size for each survey adequately describes the plant community.
4. All data from each lake is recorded and analyzed in the same format.

In short, procedural and analytical consistency makes data from different surveys suitable for comparison and evaluation, while increasing its reliability and overall utility for evaluating the health of a plant community.

The Tier I survey involves finding and identifying the major plant beds in the lake. In lakes with high water clarity, this can be accomplished visually. In lakes with low water clarity, a rake may be lowered into the water to collect plants and identify areas of abundant plant growth. The composition of each major plant bed is then recorded.

The Tier II survey involves using a specially designed rake to collect plants from numerous sites throughout the entire lake. At each site, each species found is recorded, and given an abundance rating based on the amount collected.

These protocols are currently being used by IDNR fisheries biologists to describe the plant communities of Indiana lakes. They are accepted as practical ways to describe a plant community in detail and provide quantifiable evidence as to the overall health of an ecosystem. For these reasons, the following surveys are being used to describe plant communities in all lakes applying for LARE funding.

### 8.1.1 Tier I

The Tier I reconnaissance survey is designed to identify the major plant beds present in a body of water. This is a qualitative survey designed to give an overview of the aquatic vegetation present in a lake. It identifies and documents problem areas that can be targeted when management practices are implemented. Major submersed plant beds are found visually from a boat. Each bed is given a reference number that is recorded on Tier I data sheets. The general location of these beds are recorded on a bathymetric map of the lake, and more precise locations are recorded on Tier I data sheets with the help of a WAAS enabled GPS unit.

When a major plant bed is identified, each species of plant found in that bed is recorded. Canopy ratings are given to each plant bed based on the types of plants present in that bed. The four major types of plants to be identified in this study are as follows: submersed plants, emergent plants, non-rooted floating plants and rooted floating plants.

The following scale is used to describe these four types of plants based on the percentage of the plant bed canopy they occupy:

### **Canopy Rating**

1 = < 2% of canopy

2 = 2-20%

3 = 21-60%

4 = >60% of canopy

In addition to the canopy rating, another abundance rating is given to each individual species found in a particular plant bed. This abundance rating is based on the percentage of the entire bed area that species appears to occupy. The scale for this abundance rating is the same as the canopy rating scale. The difference is that this scale identifies the abundance of *individual species* in the bed:

### **Species Abundance Rating**

1 = < 2% of the bed

2 = 2-20%

3 = 21-60%

4 = >60% of the bed



<http://dipin.kent.edu>

Secchi disk readings are taken prior to the vegetation surveys. Secchi are plate-like objects used to measure water clarity. The disk is lowered into the water until it disappears. Once it has disappeared, it is then raised slightly until it is just barely visible. At this point, marked points on the secchi rope are used to determine the maximum depth at which the disk can be seen. In lakes with clear water, the Tier I survey is primarily a visual survey, in lakes with low water clarity, rake throws and the use of electronics help to locate and describe plant beds. The

Tier I survey is a valuable tool that helps to provide an overall picture of an aquatic plant community when coupled with the Tier II quantitative survey.

### 8.1.2 Tier II

Tier II quantitative surveys of Lake Wawasee were conducted on May 26, 2005 and August 10, 2005. The purpose of these surveys was to document the distribution and abundance of submersed and floating-leaved aquatic vegetation throughout the lake (IDNR, 2004). A specific number of sample sites were selected based on the amount of surface acreage the lake possessed. Once sample sites were determined, sampling was accomplished using an aquatic vegetation sampling rake constructed according to the guidelines of the 2004 Tier II random sampling procedure manual.

Aquatic vegetation collected at each sample site was sorted according to species and given a value to represent its abundance at that site. These values were immediately recorded on data sheets distributed by the IDNR. These records were used for data analysis that served to characterize the aquatic vegetation community of Lake Wawasee.

#### Random Sampling:

The IDNR issued the following chart to help determine the number of sample sites needed to accurately describe the aquatic plant community in a lake.

**Table 3: Sample Site Protocol**

<b>Size of Water body</b>	<b>Number of Sample Sites</b>
1-100 acres	40
101-300 acres	60
Greater than 300 acres	Add 10 sites/100 acres

Based on Lake Wawasee's 3060 surface acres, 360 sample sites were needed to accurately describe this plant community. Aerial photographs and bathymetric maps were used to help space the sample sites throughout the lake. The littoral zone of the lake was divided into four quadrants of equal length. During the vegetation collection process, an effort was made to collect plants from an equal number of sites in each quadrant to ensure that the entire littoral zone was surveyed adequately and that random sample sites were distributed evenly throughout the lake.

When sampling the littoral zone of the lake, a pattern was used that also helped to ensure an accurate description of the plant community. The littoral zone was divided into three sections based on depth and sample sites alternated between each of these three zones. For example, collection site 1 would be taken in shallow water very close to shore. Collection site 2 would be taken further down the shoreline, but in slightly deeper water. Collection site 3 would be taken further down the shoreline, but in even deeper water, close to the border of the littoral and pelagic (open water) zone. This sampling strategy was recommended by District 3 fisheries biologist Jed Pearson. This strategy not only helps to accurately describe the plants in the littoral zone, but it also aids in determining the maximum depth at which plants can grow in a particular lake.

## **Aquatic Vegetation Sampling Rake:**

A double-headed garden rake was used to sample aquatic vegetation. This rake design is approved and used by IDNR fisheries biologists in vegetation surveys on many Indiana lakes. It consists of two garden rake heads welded together back to back so that rake teeth are protruding from two sides. The dimensions of the rake are to be 13.5 inches wide with 2.25-inch long teeth spaced 0.75 inches apart (IDNR, 2004).

Each tooth on the rake head is divided into five equal sections and marked accordingly. These marks on the rake teeth are used to estimate the abundance of plant species when they are collected.

A nylon rope is then attached to the rake head. A black permanent marker is used to mark the rope in foot long increments. A red mark is placed every five feet along the rope. This rope is used to measure the depth at each sample site when the rake is lowered to the lake bottom.

## **GPS and Mapping:**

A WAAS enabled GPS unit was used to obtain and record the coordinates of each sample site on the lake. A WAAS enabled GPS unit is accurate to within 3 meters and was used to obtain maximum accuracy for mapping sample sites. All GPS coordinates were then used to produce computer generated maps of the lake with each sample site labeled on the map. A spreadsheet corresponding to this map is included in the appendices of this report.

## **Sampling Procedure**

A two-person crew accomplished Tier II aquatic vegetation sampling by boat. A crew leader was responsible for driving the boat to each sample site and recording vegetation data on record sheets issued by the IDNR. An assistant was responsible for collecting the aquatic plants using the double-headed rake.

When a sample site was reached, its GPS coordinates were obtained and recorded. The boat was then brought to a complete stop, and the double-headed rake was lowered to the bottom of the lake. The boat was held stationary while the water depth at the sample site was obtained by using the marked rope attached to the rake. When water depth had been recorded, the crew leader slowly backed the boat away from the rake as the assistant simultaneously let out another ten feet of rope. During this process the rake did not move from the lake bottom.

The rake was pulled from the water after the boat had reached the end of the ten extra feet of rope let out after the depth was recorded. This ensured that the rake was pulled horizontally through the water, giving it a greater chance of collecting weeds than if the rake had been lowered to the bottom and raised vertically. The vegetation caught on the teeth of the rake was then gathered into the boat.

## **Determining Vegetation Abundance**

At each sample site, every plant species collected on the rake was scored according to its abundance. This was accomplished by removing all plants from the rake and sorting them by species. Once all plants had been sorted, they were placed back onto the rake and evenly distributed across the marks on the rake teeth. If a species filled the rake to the first mark on the teeth, that species was given a score of 1 on the abundance data sheet. If it filled the rake teeth to the second mark, it was given a score of 2, and so on to a maximum abundance of five. In many instances it was not necessary to place each species back onto the rake. Many species would fill the rake completely (an abundance of 5) and some species would only have one plant on the rake (an abundance of 1). In addition to abundance scores for individual species, each rake toss was given an overall abundance score, describing how much total vegetation was collected on the rake.

### **8.1.3 Analytical Methods**

One of the methods used to analyze the Tier II data was an IDNR Vegetation Database. Survey data was imported from Microsoft Excel and used to calculate plant community metrics that describe the plant community of a lake. This program and these metrics are used by biologists throughout the state and provide consistency in data analysis procedures. This consistency makes Tier II data more useful for comparisons between lakes and from year to year.

Delorme X-Map 4.5 was used to map major plant beds and individual species distributions. To map individual species, GPS coordinates representing each sample site where the species was collected were imported into the program and displayed on a computer generated map of the lake. For major submersed plant beds and emergent plant beds, a bathymetric map of the lake was imported into the program and geo-referenced to ensure greater accuracy for the locations of plant beds. A combination of GPS coordinates, landmarks, field notes, and the bathymetric map helped to estimate the exact locations of each plant bed. Estimates of plant bed sizes were calculated using X-Map after each bed was drawn on the bathymetric map.



## 8.2 Results

### 8.2.1 Tier I Results

The submersed plant community of Lake Wawasee covers roughly 1700 acres of the lake, or 55% of the lake's total surface area. Approximately 1100 of these acres are dominated by chara ( shown in yellow in Figure 3) although other plants are present in low to moderate abundances. In some very shallow areas of the littoral zone, especially along the east shore of the lake, aquatic plants are almost non-existent. Other very sparsely covered areas occur on the shallow shelves that ring the shoreline of the lake. Weed growth on these shallow shelves may be inhibited by substrate, wave action, boat traffic and other unknown factors. Denser weed beds cover roughly 600 acres of the lake, or about 20% of the lake's total surface area (shown in red and blue in figure 3). These weed beds are found near the deeper edge of the littoral zone, as well as in near shore areas of more protected bays with softer, mud bottoms. These weed beds can grow to a maximum depth of almost 25 feet. Eurasian watermilfoil is found predominantly in these heavier weed beds (600 acres) and is frequently found intermingled with native species, although in many cases its abundance is low or moderate.

The plant beds in Conklin Bay, Johnson's Bay, and the smaller bay behind Morison Island (beds #10, #7, and #5 in figure 3) differ from most of the other plant beds in the lake. They were very diverse for their size, and vegetative growth was usually more dense in these areas. While near shore areas on the main lake are largely covered by chara, near shore areas in these bays are more likely to harbor dense beds of milfoil species, coontail, curly leaf pondweed, and other macrophytes. Bottom content appears to have a much higher organic content than most main lake weed beds. This may facilitate higher plant diversity and more abundant plant growth in these areas.

Plant beds #3, #9, #11, and #15 in figure 3 were all small, near shore beds that differed from the expected near shore composition. Instead of being dominated by chara, these beds were more dense and had much more vertical structure, being dominated by milfoils and other plants.

#### **Problem Plant Areas:**

While many of the shallow channels adjacent to Lake Wawasee become weed choked, many of the shallow areas of the main lake are only sparsely covered with vegetation. Significant weed problems in docking areas are few, although in protected bays, weed growth can become overabundant. The areas affected by invasive species are found in the plant beds along the drop off near the deep edge of the littoral zone in plant bed # 2, as well as in the bays (plant beds #5, #7, and #10 in figure 3). Eurasian watermilfoil is present in these beds, and it is distributed throughout the lake. While its wide distribution is cause for concern, its overall dominance score was just over 5 in both surveys, which is relatively low. Natives are well established in Lake Wawasee, and their abundance may be helping to limit the distribution and abundance of Eurasian watermilfoil. The Eurasian watermilfoil population should be monitored closely in the years to come, especially in the more heavily infested areas along the south shore of the lake near the public access site.

One area that can be troublesome for boaters is the large sand bar that almost extends across the entire lake. This sand bar starts from the point where plant bed #1 is labeled on the submersed plant bed map and extends north into the middle of the lake. While a portion of this bar is a popular spot because of its sandy bottom content, the deeper areas of the bar are home to very dense weed beds which can cause problems for both motor boats and sailboats.

### **Beneficial Plant Areas:**

Some of the most important plant areas on Lake Wawasee are the large sections of emergent plants along the south shore of Conklin Bay (emergent bed #6) and the north end of Johnson's Bay (emergent bed #3). With a combined size of about 240 acres, these wetland areas account for the vast majority of wetland acreage on the shoreline of Lake Wawasee. White lilies, spatterdock, arrowhead, and cattails are common in these wetland areas, other native plants are present in these beds as well. The benefits of wetlands are well documented, and Lake Wawasee has historically had high water quality, thanks to the many water-filtering wetlands in its watershed. This makes the protection of wetland areas in the Lake Wawasee watershed an extremely high priority.

Both the Conklin Bay and the Johnson's Bay wetland areas may be decreasing in size due to boating traffic. Also, bulrushes that were once abundant on the lake's large sandbar and other areas, according to lake residents, were only present in very small patches during the 2005 surveys. These bulrush beds may be decreasing in size due to disturbance caused by boats. Idle speed zones have been established to protect the Conklin Bay and Johnson's Bay wetland areas as well as a small strand of bulrushes along the north shore of the lake (emergent bed #5). These areas should be monitored to ensure that they do not continue to decrease in size.

Other beneficial plant areas include the submersed weed beds #5, #7, #10, and #11. These plant beds offer vertical structure in shallow water as opposed to the sparse chara beds that inhabit much of the lake's shallow water. These large section's shallow structure are no doubt important as a nursery for young fish, as well as habitat for reptiles and amphibians.

During the 2005 Tier I surveys, 16 major plant beds were identified. Major factors correlated with plant bed composition were depth, bottom substrate, and protection from wave action. The following table summarizes species abundance in each plant bed.

Table 4: Tier I Summary

## Lake Wawasee 2005 Tier I Survey Summary

Species Abundance by Plant Bed #

	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16
<b>Plant Species</b>																
American Pondweed															1	
Chara	4	1	1	2	2	1	2	4	1	2	1				1	
Illinois Pondweed	1									1						
Eurasian watermilfoil	1	2	1		2	2	1		2	1	1	2	2	2	1	3
Slender Naiad	1		1		1			1		1						
Flat-stem Pondweed	1	1			1	1		1			1					
Whorled Watermilfoil	1		2	2			3	2							3	
Sago Pondweed	1	2			1		1			1						
Largeleaf Pondweed							1									
Eelgrass	1	1		4	1	1		1	3	2					1	
Curly-Leaf Pondweed	1				2		1	1		3						
Coontail		2			1	2	1			2	2	2	2	2		2
Elodea	1									1	1					
Northern Milfoil	1	3			2	3				1	1	3	3	3	2	3
Richardson's Pond.		1				1										1
Duckweed					1						1					
Bladderwort		2	3	1		2		1		1	3	2	2	2	1	
Variable Pondweed	1	1	1				1			1						
<b>Total # of Species</b>	<b>12</b>	<b>10</b>	<b>6</b>	<b>4</b>	<b>9</b>	<b>8</b>	<b>8</b>	<b>7</b>	<b>3</b>	<b>12</b>	<b>8</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>7</b>	<b>4</b>
<i>Size (Acres)</i>	<i>546</i>	<i>559</i>	<i>7</i>	<i>7.5</i>	<i>25</i>	<i>7</i>	<i>47</i>	<i>443</i>	<i>5</i>	<i>35</i>	<i>26</i>	<i>3</i>	<i>5</i>	<i>1.5</i>	<i>11</i>	<i>1</i>

### Species Abundance Rating

1 = < 2% of the bed

2 = 2-20%

3 = 21-60%

4 = >60% of the bed

#### Plant Bed #1

Size: 546 acres

Substrate: Sand/Gravel

Number of Species: 12

**Description:** This was the second largest plant bed found in Lake Wawasee. Even though its size is very large, it showed consistency in both structure and composition throughout. This bed runs along the shoreline of the lake from the southeast end of Conklin Bay, counter clockwise to the east shore of Johnson's Bay. This plant bed is dominated by chara (<60%), although 11 other plant species are present in low abundance. Wave action caused by wind and boating may play a role in limiting vegetation growth in this bed, as could the lack of nutrients in the substrate.

**Plant Bed #2**

Size: 559 acres

Substrate: Sand/Silt

Number of Species: 10

**Description:** This was the largest plant bed found in Lake Wawasee. It occurs in approximately 8-25 feet of water and rings nearly the entire littoral zone of the lake. During the Tier I survey, rake tosses were used periodically to verify that this was indeed a continuous ring of plants and not separate plant beds. The only noticeable break in this plant bed was in Johnson's Bay, where it mixed with plant bed #7. This plant bed has significantly more vertical structure than plant bed #1. The bed is much denser than plant bed #1 and is dominated by northern and Eurasian watermilfoil, as well as coontail and bladderwort. These plants each accounted for about 10-20% of the area covered by the bed. Chara was found in low abundance (<2%) as was flat-stemmed pondweed, eelgrass, Richardson's pondweed, and variable pondweed.

**Plant Bed #3**

Size: 7 acres

Substrate: Sand/Silt

Number of Species: 6

**Description:** This was a relatively small plant bed at 7 acres. It is located just west of the IDNR's public access site, near the mouth of an inlet stream. It is a near shore bed that has more structural characteristics of the deeper plant beds in Lake Wawasee. Instead of being dominated by chara, the two most prevalent species were bladderwort (21-60%) and whorled watermilfoil. Chara, Eurasian watermilfoil, slender naiad, and variable pondweed were all present in low abundance (<2%).

**Plant Bed #4**

Size: 7.5 acres

Substrate: Sand/Silt

Number of Species: 4

**Description:** This plant bed runs along the shoreline in the area by the yacht club, just north of the IDNR public access site. This is one of the few places where eelgrass was abundant in Lake Wawasee. Eelgrass accounted for over 60% of the bed. Whorled watermilfoil was present in approximately 20% of the bed. Chara was present with an abundance between 2 and 20% , and bladderwort was present in low abundance (<2%).

**Plant Bed #5**

Size: 25 acres

Substrate: Sand/Silt

Number of Species: 9

**Description:** This plant bed is located in the back of a relatively protected bay, just southeast of Morison Island. This is another near shore bed that displays characteristics of the deeper plant beds in Wawasee. Bottom substrate in this bay appeared to hold much more organic matter than shallow areas out in the main lake. This bay was one of the few places where curly leaf pondweed was fairly abundant at approximately 20%. The soft bottom of this area may be conducive to the curly leaf pondweed. Northern milfoil, Eurasian watermilfoil and chara were all present with abundances close to 20% as well. Slender naiad, flat-stemmed pondweed sago pondweed, eelgrass, coontail, and duckweed were all present in low abundance (<2%).

**Plant Bed #6**

Size: 7 acres

Substrate: Sand/Silt

Number of Species: 8

**Description:** This plant bed forms a ring around a small deep hole located in the same bay as plant bed #5. This deep bed is very similar in structure and size to plant bed #2. Northern milfoil was the dominant plant in this bed at 21-60%, while Eurasian watermilfoil, coontail and bladderwort were all present with abundances close to 20%. Chara, flat-stemmed pondweed, eelgrass, and Richardson's pondweed were all present in low abundance (<2%).

**Plant Bed #7**

Size: 47 acres

Substrate: Sand/Silt

Number of Species: 8

**Description:** This plant bed is located on the shallow flats of Johnson's Bay. In this plant bed, whorled watermilfoil was the most prevalent species at 21-60%. Chara was present with an abundance of about 20%, while Eurasian watermilfoil, sago pondweed, eelgrass, curly leaf pondweed, coontail, variable pondweed were all present in low abundance. This was also one of the few places where large leaf pondweed was present. It had an abundance of <2%.

**Plant Bed #8**

Size: 443 acres

Substrate: Sand/Gravel

Number of Species: 7

**Description:** This was another very large plant bed at 443 acres. It runs along the shoreline of the northeast section of the lake and extends into the southern portion of Johnson's Bay. This plant bed is almost identical in structure to plant bed #1. Chara dominates this bed at approximately 80%, while whorled watermilfoil was found in moderate abundance between 2-20%. Slender naiad, flat-stemmed pondweed, eelgrass, curly leaf pondweed, and bladderwort were all found in low abundance (<2%).

**Plant Bed #9**

Size: 5 acres.

Substrate: Sand/Silt

Number of Species: 3

**Description:** This near shore plant bed was located in a small bay at the north end of the lake. It differed from the surrounding area, in that chara was not the dominant species. Eelgrass was the most dominant species, while Eurasian watermilfoil was also more dominant than chara. This bed also had sections of bare ground, but enough vegetation growth was found to consider it a plant bed, especially since it had a different composition than the surrounding area.

**Plant Bed #10**

Size: 35 acres

Substrate: Sand/Silt

Number of Species: 12

**Description:** Plant bed #10 covers the majority of Conklin Bay. This is a very diverse bed, containing 12 species. It is tied with plant bed #1 for harboring the most species, even though it is much smaller than plant bed #1. Curly leaf pondweed was fairly abundant in this bed ranging between 21-60%. Eelgrass, coontail, and chara were all present with abundances close to 20%. Illinois pondweed, Eurasian watermilfoil, slender naiad, sago pondweed, elodea, northern milfoil, bladderwort, and variable pondweed were all present in low abundance.

**Plant Bed #11**

Size: 26 acres

Substrate: Sand/Silt

Number of Species: 8

**Description:** This plant bed runs along the south shore of Conklin Bay adjacent to the large wetland area. Bladderwort was the most prevalent plant in this bed at about 60%. Coontail was the second most dominant plant, at about 20% of the bed. Elodea was present in low abundance, as was chara, Eurasian watermilfoil, flat-stemmed pondweed and northern milfoil. Duckweed was present in this bed as well, which is an indicator of high nutrient concentrations in the water in this area.

**Plant Bed #12**

Size: 3 acres

Substrate: Sand/Silt

Number of Species: 4

**Description:** This plant bed lies atop a very small, shallow rise in the middle of an open expanse of water. These mid-lake rises have incredibly steep drop offs, making their edges very difficult to located and sample. Plant composition on these humps is assumed to be very similar to plant bed #16, which is a mid-lake rise that was found and sampled extensively. Composition on these mid -lake rises is very similar to plant bed #2. Northern milfoil and Eurasian watermilfoil are the dominant species, while bladderwort and coontail are also present in slightly lower abundance at approximately 20%.

**Plant Bed #13**

Size: 5 acres

Substrate: Sand/Silt

Number of Species: 4

**Description:** This plant bed is located straight south of plant bed #12 and is assumed to have similar composition, with northern milfoil and Eurasian watermilfoil being dominant, followed by bladderwort and coontail.



**Plant Bed #14**

Size: 1.5 acres

Substrate: Sand/Silt

Number of Species: 4

**Description:** This plant bed is also a mid-lake rise located straight south of plant beds #12 and #13. It is smaller than both of these beds, at 1.5 acres. Composition is considered the same as plant beds #12 and #13.

**Plant Bed #15**

Size: 11 acres

Substrate: Sand/Silt

Number of Species: 7

**Description:** This is a near-shore bed with composition very similar to plant beds #5 and #7. Bottom content appeared to hold much higher organic content than most sections of the main lake shoreline. Whorled watermilfoil was dominant at approximately 60%, while northern milfoil was the second most abundant plant in this bed. Eurasian watermilfoil was present with an abundance between 2 and 20%. Chara, eelgrass, and bladderwort were all present in low abundance. American pondweed was also observed in this area in low abundance.

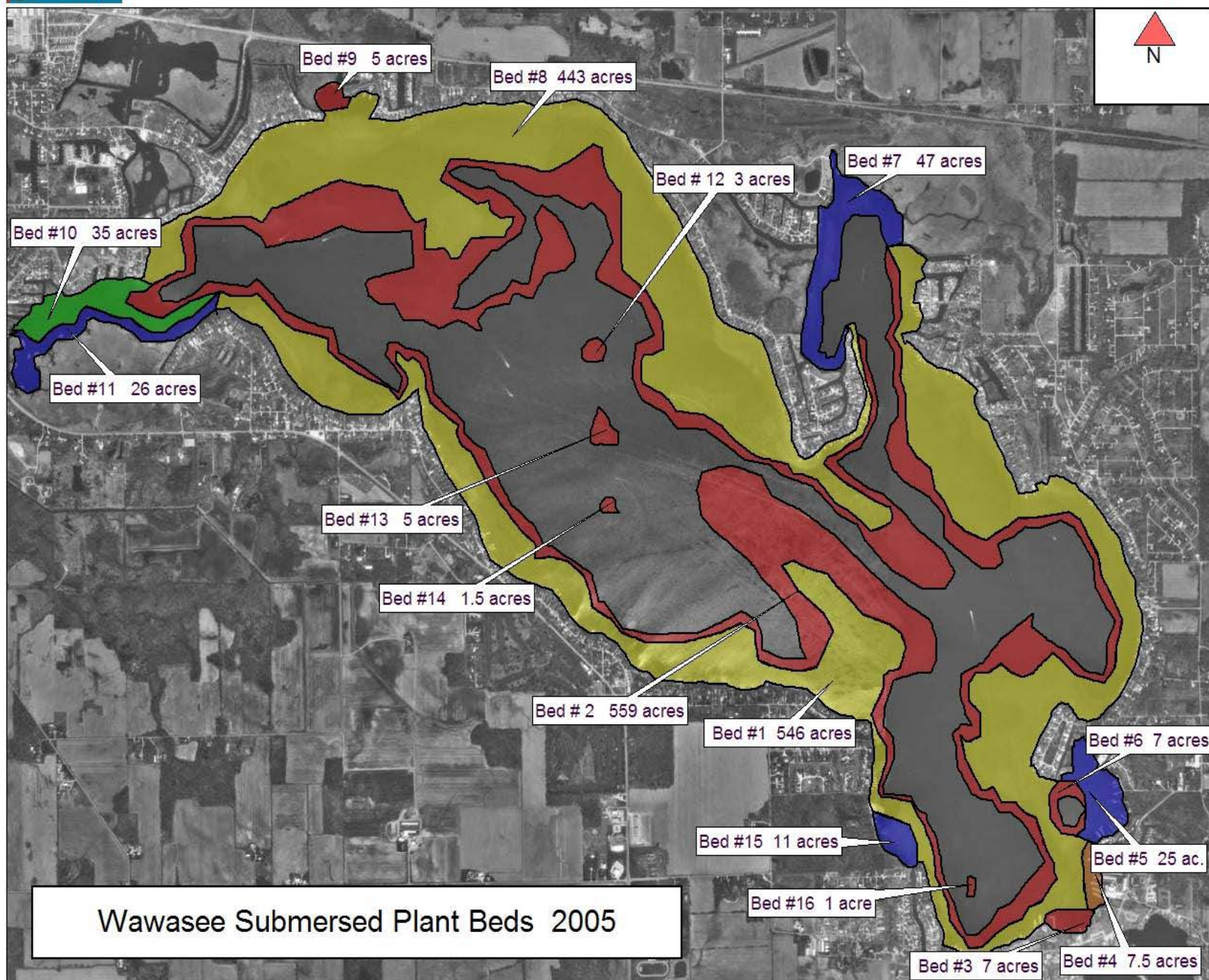
**Plant Bed #16**

Size: 1 acre

Substrate: Sand/Silt

Number of Species: 4

**Description:** This plant bed is a very small mid-lake rise, only 1 acre in size. Rake throws were used to determine the composition of this bed. Eurasian watermilfoil and Northern milfoil were both abundant at approximately 40% each. Coontail was present in moderate abundance at approximately 20%, while Richardson's pondweed was present in very low abundance (<2%).



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0 800 1600 2400 3200 4000 ft  
Data Zoom 12-7

Figure 3: Submersed Plant Beds

Although Lake Wawasee holds a high number of significant wetlands in its water shed, wetland areas along the shoreline of the lake are scarce. There are two large wetlands (Johnson's Bay and Conklin Bay), but few other significant wetlands are present throughout the lake. Historically, significant wetland areas were present on "the sandbar" and other shallow flats on the main lake. According to lake residents, these main lake wetlands have disappeared as boat traffic has increased over the years on Wawasee. Seven major wetland areas were found on Lake Wawasee in the 2005 surveys. These emergent beds cover an estimated 263 acres, or 8.5% of Lake Wawasee's 3060 surface acres. The following table summarizes the results of the Tier I emergent plant survey.

**Table 5: 2005 Emergent Plant Bed Summary**

### **Lake Wawasee Tier I Emergent Plant Beds**

Species Abundance By Plant Bed #							
	#1	#2	#3	#4	#5	#6	#7
<b><u>Plant Species</u></b>							
White Lilly	1	1	1	1		2	
Spatterdock	4	1	2	2		3	2
Cattail		4	4	4		4	4
Arrowhead	2	1	1	1			
Soft Stem Bulrush					4		
Common hackberry						1	
Willow sp.						1	
Iris sp						1	
Purple loosestrife							3
Rose Mallow						1	
<b>Total # of Species</b>	<b>3</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>1</b>	<b>7</b>	<b>3</b>
<b>Size (Acres)</b>	<b>1.5</b>	<b>2.5</b>	<b>150</b>	<b>14</b>	<b>0.5</b>	<b>90</b>	<b>4.5</b>

#### **Emergent Bed #1**

Size: 1.5 acres

Substrate: Sand/Silt

Number of Species: 3

**Description:** This emergent bed is located in the bay behind Morison Island, northeast of the IDNR public access site. Three emergent plant species were present in this bed. Spatterdock was dominant, covering over 60% of the bed. Arrowhead covered approximately 20% of the bed, while white lilies were found in low abundance.

#### **Emergent Bed #2**

Size: 2.5 acres

Substrate: Sand/Silt

Number of Species: 4

**Description:** This emergent bed is located in the same bay as plant bed #1, adjacent to Griffith's Wawasee Marina. It is the area known as "the kettle" by many locals. It contains 4 species of emergent plants. Spatterdock was dominant in this bed as well. Arrowhead was present in lower abundance between 15-20%. White lilies were present in low abundance (<2%), and cattails were present in low abundance closer to shore.

**Emergent Bed #3**

Size: 150 acres

Substrate: Sand/silt

Number of Species: 4

**Description:** This was the largest plant bed found in Lake Wawasee at 150 acres. It is located at the northeast end of Johnson's bay. The majority of this plant bed was not navigable, so aerial data software was used to estimate the size of this bed. Four species of emergent plants were found in this bed. Cattails were dominant throughout the bed, while spatterdock, white lilies, and arrowhead were found in the open water areas of this wetland. Spatterdock was the most dominant plant in the open water area but was still found in very low abundance when compared to the overall size of the bed.

**Emergent Bed #4**

Size: 14 acres

Substrate: Silt/Clay

Number of Species: 4

**Description:** This wetland area is located on the west shore of Johnson's Bay. Its composition is much the same as the larger wetland (bed#3) in Johnson's Bay. Cattails were dominant, while spatterdock, white lilies and arrowhead were all found in low abundance in the open water portion of this bed.

**Emergent Bed #5**

Size: 0.5 acres

Substrate: Sand

Number of Species: 1

**Description:** This is a very small stand of soft stem bulrushes located at the mouth of a small bay on the north shore of the lake. Bulrushes were once common throughout the lake but have declined significantly in recent years. There is an idle zone by these bulrushes that should help protect them from boat traffic. The size of this bulrush bed should be closely monitored in the future.

**Emergent Bed #6**

Size: 90 acres

Substrate: Sand/Gravel

Number of Species: 7

**Description:** This emergent bed is the second largest wetland along the Wawasee shoreline, at 90 acres. It is located along the south shore of Conklin Bay. Aerial data software was used to estimate the size of this bed because most of this area was not navigable. It was also the most diverse emergent bed, containing 7 species. Cattails were the overall dominant plant in this bed scoring greater than 60%, while spatterdock dominated the open water area of this bed. White lilies were present in the open water of this bed between 2-20%, and Iris species, willow species, common hackberry, and rose mallow were all present in low abundance along the shoreline of this wetland.

**Emergent Bed #7**

Size: 4.5 acres

Substrate: Sand/Silt

Number of Species: 2

**Description:** This bed is located on the southwest shoreline between the entrances to the Leeland and Marineland channel systems. Three species of emergent plants were found in this bed. Cattails dominated less than 60% of this plant bed, while spatterdock was the only species in the open water area. Purple loosestrife was fairly abundant along the shoreline in this wetland area at approximately 30%.



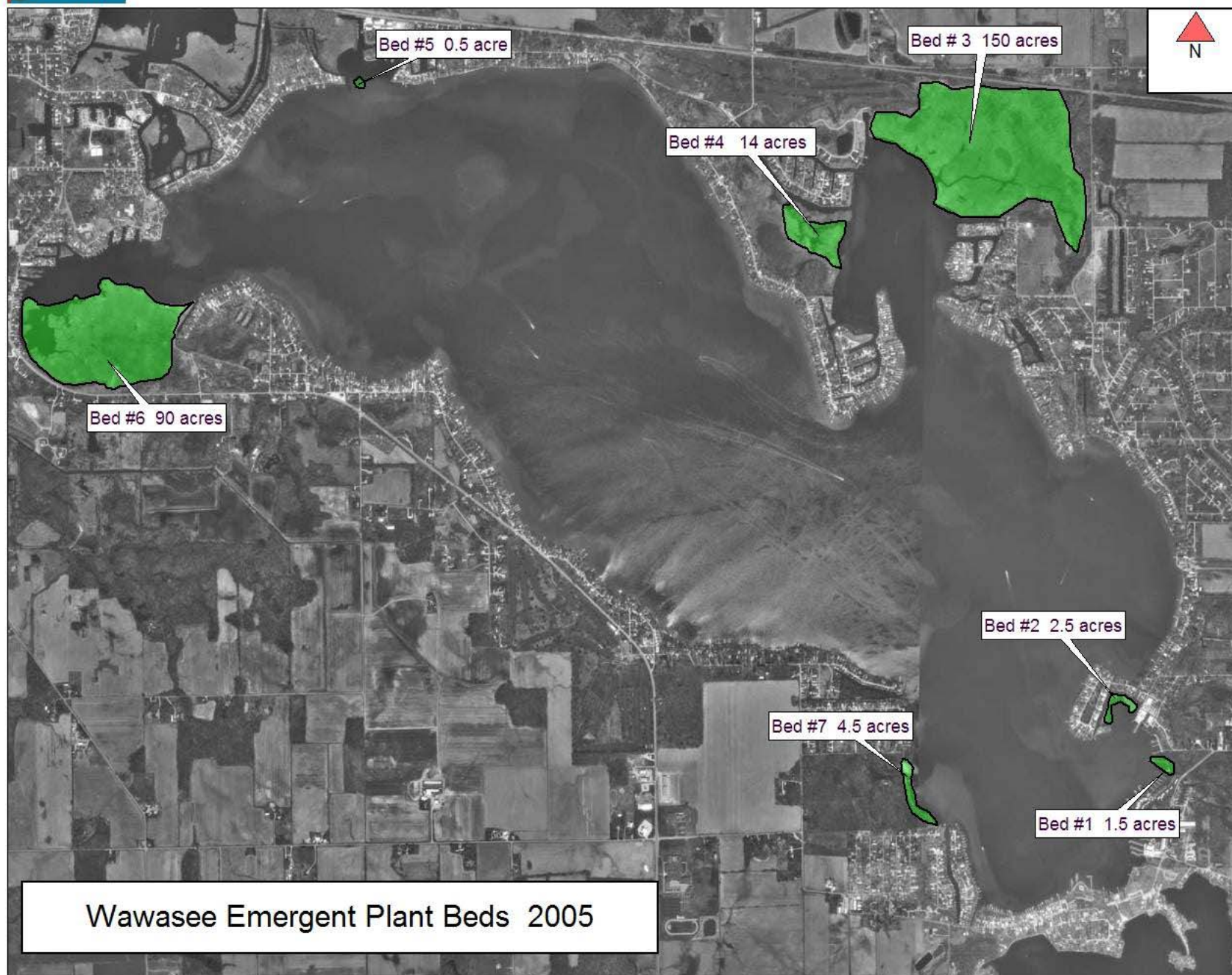


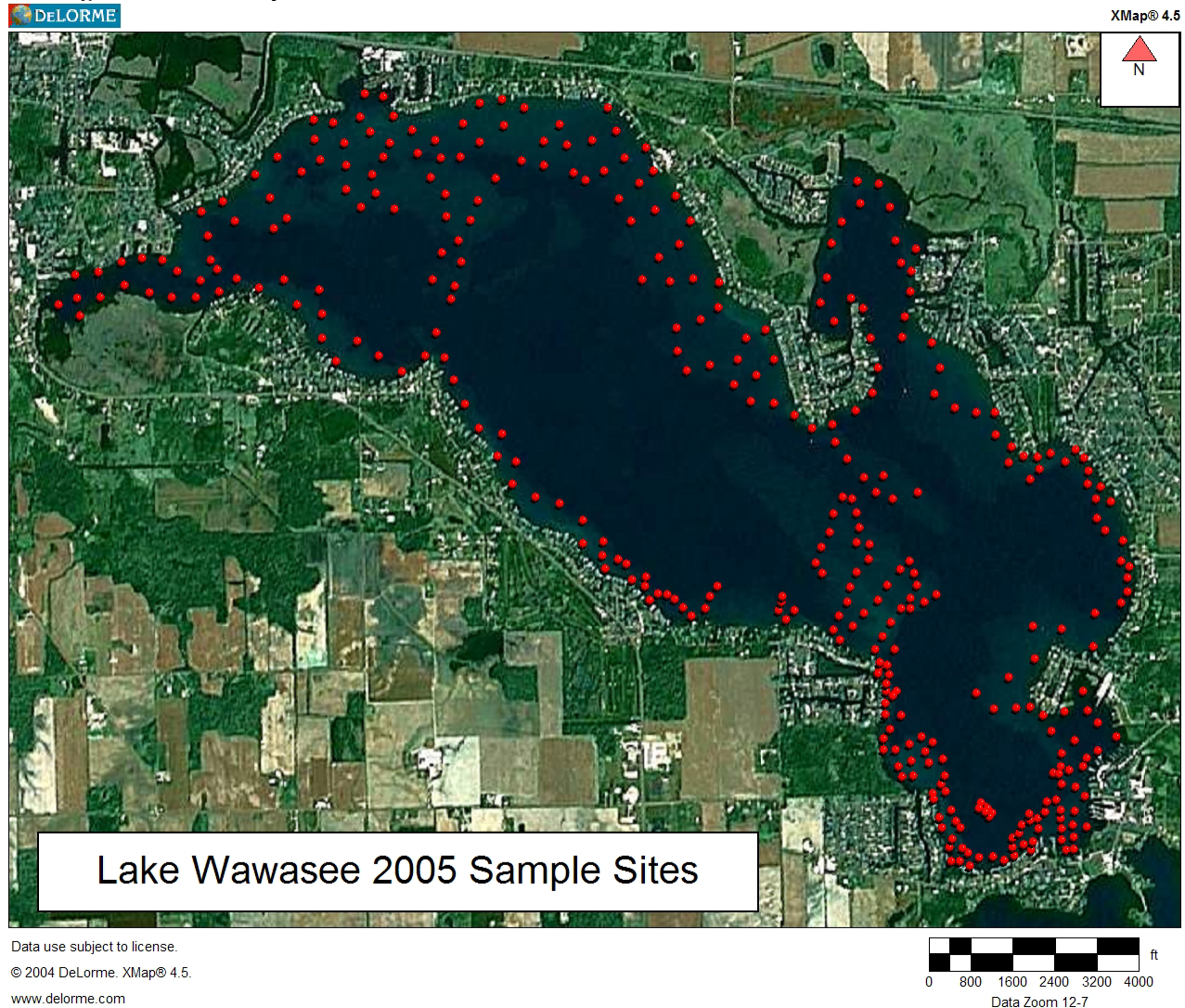
Figure 4: Emergent Plant Beds



## 8.2.2 Tier II Results

Secchi depth was taken prior to both surveys and determined to be approximately 10 feet. The first survey was conducted on May 26, 2005. Three hundred and sixty rake samples were distributed throughout the lake. A total of 16 species of submersed aquatic plants were collected during the spring 2005 Tier II survey. Of these 15 species, two of them (Eurasian watermilfoil and curly-leaf pondweed) were exotic. The following map shows the locations of all sample sites during the May survey. These sample sites were marked with GPS and sampled again in August.

**Figure 5: 2005 Sample Sites**



The summer survey was conducted on August 10, 2005. Rake throws were made at each one of the 360 sample sites marked in the spring survey. In this Tier II survey, 20 species of submersed aquatic plants were collected. Major increases were seen in distributions and abundances of many species, which is expected as the growing season progresses. Tables 6 and 7 summarize the results of the Tier II surveys:

Table 6: May 2005 Tier II Summary

## Occurrence and Abundance of Submersed Aquatic Plants

Date: 5/26/05		Littoral sites with plants: 307		Species diversity: 0.81
Littoral depth (ft): 25.0		Number of species: 16		Native diversity: 0.75
Littoral sites: 360		Maximum species/site: 5		Rake diversity: 0.81
Total sites: 360		Mean number species/site: 1.56		Native rake diversity: 0.74
Secchi: 10.0		Mean native species/site: 1.33		*Mean rake score: 1.38
Common Name	Site frequency	Relative density	Mean density	Dominance
Chara	59.7	0.72	1.20	14.3
Northern milfoil	22.2	0.34	1.55	6.9
Eurasian watermilfoil	12.8	0.27	2.13	5.4
Coontail	10.6	0.15	1.45	3.1
Clasping-leaf Pondweed	10.3	0.10	1.00	2.1
Curly-leaf Pondweed	10.3	0.11	1.11	2.3
Flat-stemmed Pondweed	5.0	0.05	1.00	1.0
Bladderwort	4.7	0.05	1.00	0.9
Whorled milfoil	3.9	0.04	1.00	0.8
Waterstargrass	3.3	0.03	1.00	0.7
Slender naiad	3.3	0.03	1.00	0.7
Eel Grass	2.5	0.03	1.00	0.5
Large-leaf Pondweed	2.2	0.02	1.00	0.4
Sago Pondweed	1.9	0.02	1.00	0.4
Nitella	1.7	0.02	1.00	0.3
Elodea sp	0.8	0.01	1.00	0.2



Table 7: August 2005 Tier II Summary

### Occurrence and Abundance of Submersed Aquatic Plants

Diversity and Abundance of Submersed Aquatic Plants					
		Littoral sites with			
Date:	8/10/05	plants:	324	Species diversity:	0.88
Littoral depth (ft):	25.0	Number of species:	20	Native diversity:	0.86
Littoral sites:	360	Maximum species/site:	8	Rake diversity:	0.88
		Mean number		Native rake	
Total sites:	360	species/site:	2.05	diversity:	0.87
		Mean native			
Secchi:	10.0	species/site:	1.93	*Mean rake score:	2.59

Common Name	Site frequency	Relative density	Mean density	Dominance
Chara	55.3	0.98	1.77	19.6
Slender naiad	18.9	0.26	1.35	5.1
Variable Pondweed	18.6	0.24	1.28	4.8
Bladderwort	18.3	0.41	2.26	8.3
Northern milfoil	18.3	0.45	2.47	9.1
Coontail	15.3	0.43	2.82	8.6
Eel Grass	14.7	0.32	2.19	6.4
Eurasian watermilfoil	11.1	0.28	2.48	5.5
Sago Pondweed	9.7	0.24	2.43	4.7
Whorled milfoil	7.2	0.14	2.00	2.9
Clasping-leaf Pondweed	4.7	0.11	2.24	2.1
Flat-stemmed Pondweed	2.5	0.03	1.22	0.6
Arrowhead sp.	2.5	0.04	1.44	0.7
Southern Naiad	2.5	0.03	1.33	0.7
Illinois Pondweed	2.2	0.03	1.38	0.6
Brittle Naiad	0.8	0.01	1.67	0.3
American Elodea	0.6	0.01	1.00	0.1
Curly-leaf Pondweed	0.6	0.01	1.00	0.1
Horned Pondweed	0.3	0.00	1.00	0.1
Nitella	0.3	0.00	1.00	0.1

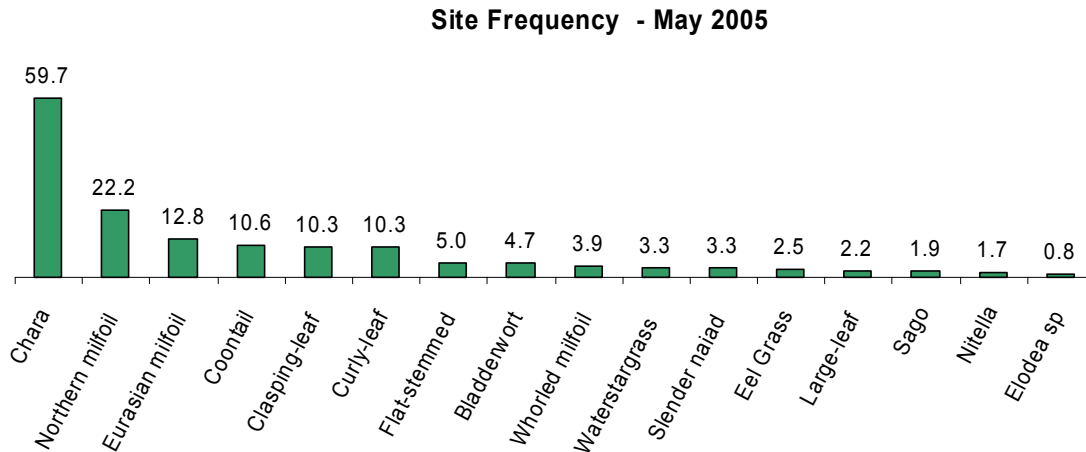
### Site Frequency

Site frequency measures how often a species was collected during the Tier II survey. It can be calculated by the following equation:

$$\text{Site Frequency} = \left( \frac{\text{\# of sites where the species was collected}}{\text{Total \# of littoral sample sites}} \right) \times 100$$

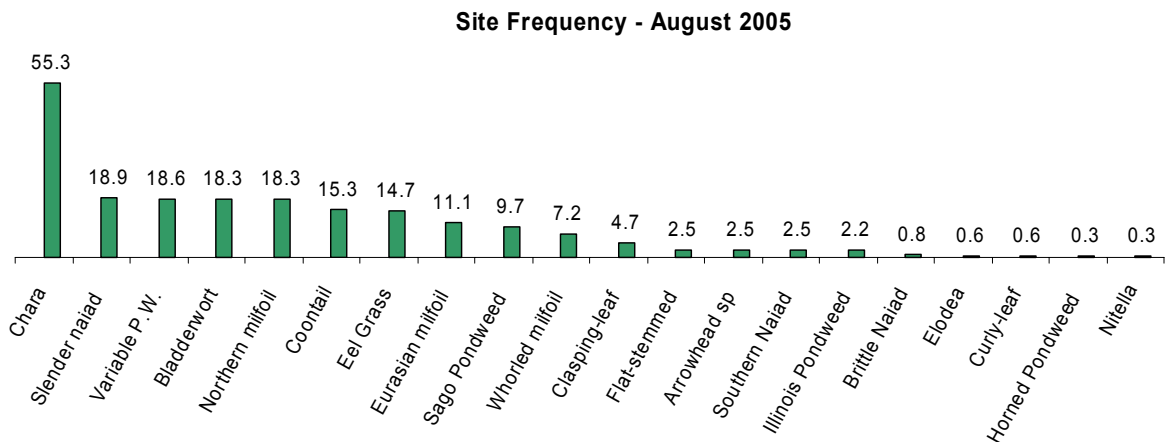
Chara was the most frequently sampled plant in the spring survey, being collected at 59.7 percent of the sample sites. Northern milfoil was second, being collected at 22.2 percent of the sample sites. Eurasian watermilfoil was collected at 12.8 percent of the sites. Coontail was collected at 10.6 percent of the sites. Clasping leaf pondweed and curly leaf pondweed were both collected at 10.3 percent of the sites. Nine species had site frequencies of 5.0 percent or less (Figure 6).

Figure 6: May Site Frequency



In the summer survey, chara was still the most frequently collected species with a site frequency of 55.3 percent, a slight decrease from the May survey. Northern milfoil site frequency decreased slightly to 15.3 percent. Slender naiad had increased from only 3.3 percent in the spring, to 18.9 percent in August, making it the second most collected plant. Variable pondweed was not collected in the spring but was collected at 18.6 percent of the August survey sites. Bladderwort was collected at only 4.7 percent of the May sample sites but was collected at 18.3 percent of the sample sites in the August survey (Figure 7).

Figure 7: August Site Frequency



### Mean Density and Relative Density

Mean Density measures the abundance of a species in areas where it is growing. For example, a species can have a high site frequency but still have a very low mean density. This means that a species may be prevalent throughout an entire lake, but it may also be sparsely scattered. Mean density can be calculated using the following equation:

$$\text{Mean Density} = \frac{(\text{The sum of all rake scores for a species})}{(\text{Total \# of sites where the species was collected})}$$

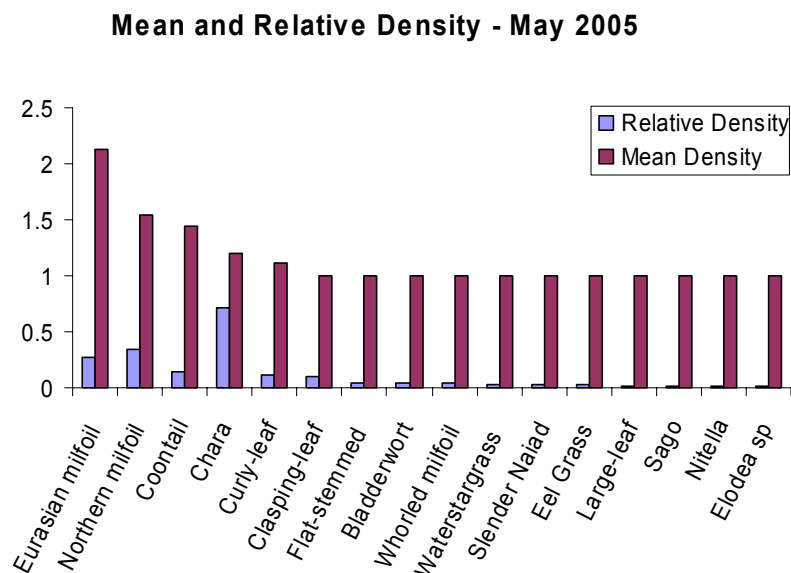
Relative Density is calculated much like mean density, but, in this case, the sum of the rake scores for a species is divided by the total number of sample sites in the survey.

Unless a species was collected at every sample site, the relative density will always be smaller than the mean density.

$$\text{Relative Density} = \frac{(\text{The sum of all rake scores for a species})}{(\text{Total \# of littoral sample sites})}$$

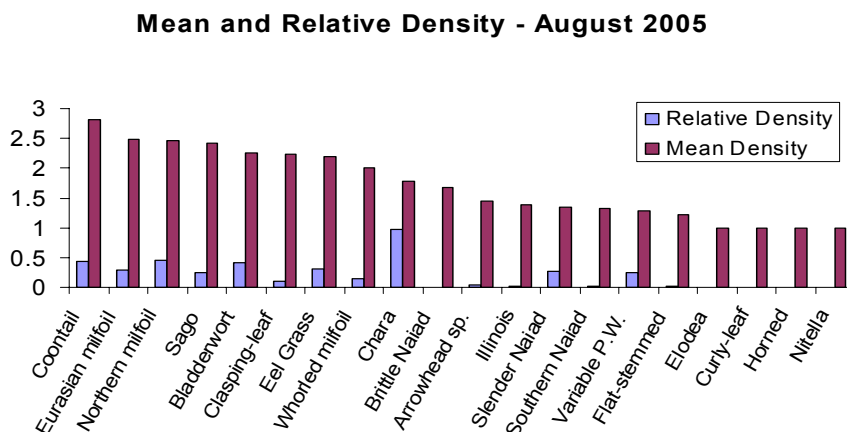
In spring of 2005, Eurasian watermilfoil had the greatest mean density, but ranked third in relative density. Chara was ranked fourth in mean density but was first in relative density because it was collected at so many sites. Northern milfoil was second in both mean density and relative density (Figure 8).

**Figure 8: May Plant Densities**



By summer, Chara was ranked ninth in mean density but still ranked first in relative density. Coontail was ranked first in mean density and third in relative density. Eurasian watermilfoil was ranked second in mean density and fifth in relative density. Northern milfoil ranked third in mean density and second in relative density.

**Figure 9: August Plant Densities**



## Species Diversity

The species diversity indices listed in Tables 6 and 7 help to describe the overall plant community. A species diversity index is actually measured as a value of uncertainty (H). If a species is chosen at random from a collection containing a certain number of species, the diversity index (H) is the probability that a chosen species will be different from the previous random selection. The diversity index (H) will always be between 0 and 1. The higher the H value, the more likely it is that the next species chosen from the collection at random will be different from the previous selection (Smith, 2001). This index is dependant upon species richness and species evenness, meaning that species diversity is a function of how many different species are present and how evenly they are spread throughout the ecosystem.

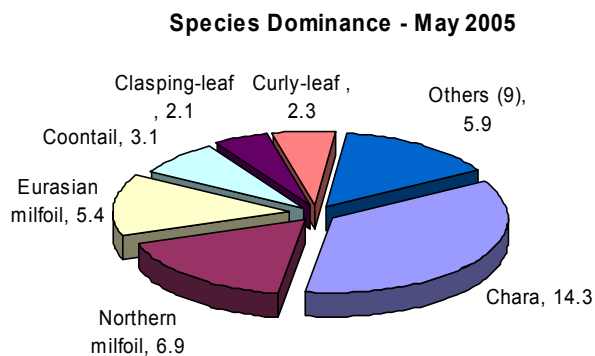
The species diversity index for Lake Wawasee in the May survey was 0.81 and this diversity index increased to 0.88 in the August survey. Many plants like eel grass and naiad are not prevalent until mid summer, which could account for higher diversity values in the summer. Native plant diversity in the May survey was measured at 0.75. This value is slightly lower than the total species diversity, simply meaning that exotic species account for some of the diversity in Lake Wawasee. Native diversity increased as well in the August survey, with a value of 0.86. Rake diversity was measured at 0.81 in the May survey and increased slightly in the August survey to 0.88. Native rake diversity increased from 0.74 in May to 0.87 in August.

The average (mean) rake score for the May survey was 1.38, and the average rake score for the August survey was 2.59. This indicates an overall increase in plant biomass as the growing season progresses.

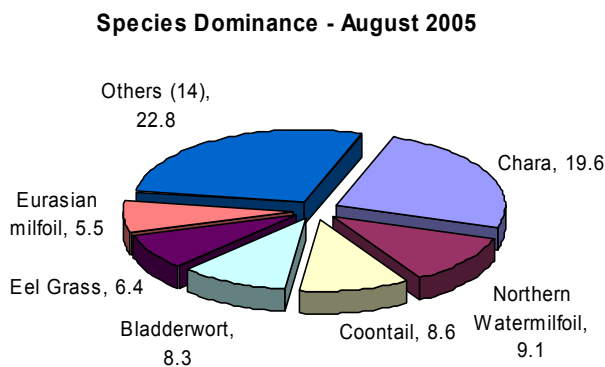
## Species Dominance

Species dominance is dependent upon how many times a species occurs and its relative coverage area or biomass within the system. In this survey, the abundance rating given to each species at each sample site was used to determine dominance. The dominance of a particular species in this Tier II survey increases as its site frequency and relative abundance increase.

In the May survey Chara was the most dominant species with a dominance score of 14.3, followed by northern milfoil which had a dominance score of 6.9. Eurasian watermilfoil had a dominance score of 5.4, and coontail had a score of 3.1. Curly leaf pondweed had a score of 2.3, and clasping leaf pondweed had a score of 2.1. Ten other species had scores less than 2 (Figure 10).

**Figure 10: May Plant Dominance**

By August, chara was still the most dominant species with a dominance score of 19.6. Northern milfoil was still the second most dominant species with a score of 9.1. Coontail had a score of 8.6. Bladderwort had a score of 8.3. Eel grass had a score of 6.4. Eurasian watermilfoil had a score of 5.5. Fourteen other species had scores less than 5.5 (Figure 11).

**Figure 11: August Plant Dominance**

The average number of total species collected at each sample site in the May survey was 1.56 while the August survey collected an average of 2.05 species per site. The average number of native species collected at each site in the May survey was 1.33 and increased to 1.93 in the August survey.

One area of special concern is the extreme southern portion of the lake near the IDNR public access site. This is the area where Eurasian milfoil is most abundant, and this area should receive special attention in the years to come. Data collected in this area has been separated from the data collected in the rest of the lake. This will help provide more detailed information to more effectively monitor the Eurasian watermilfoil population in this area. Figure 14 shows locations and abundances of Eurasian watermilfoil in this area.

Figure 12: South Basin Eurasian watermilfoil Sites

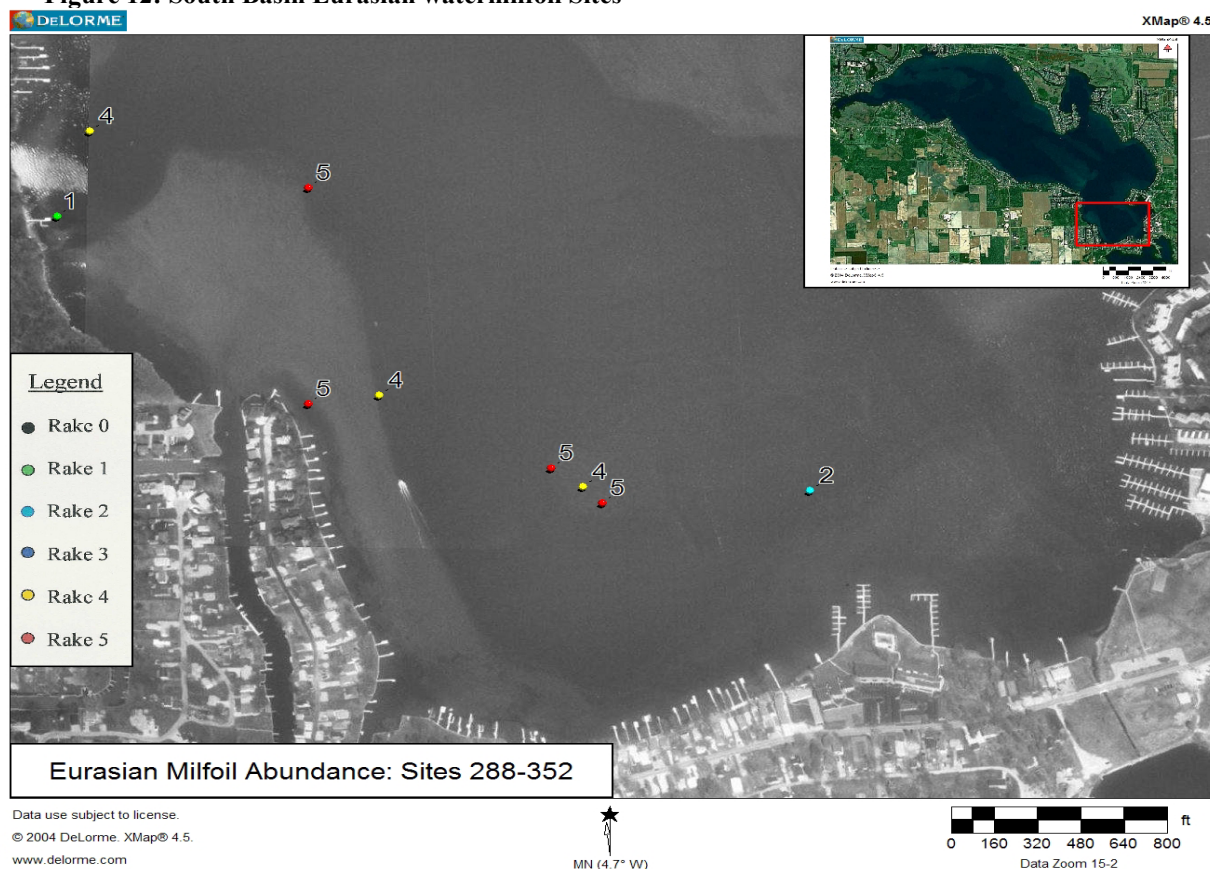


Table 8: May South Basin Tier II Summary

## Occurrence and Abundance of Submersed Aquatic Plants

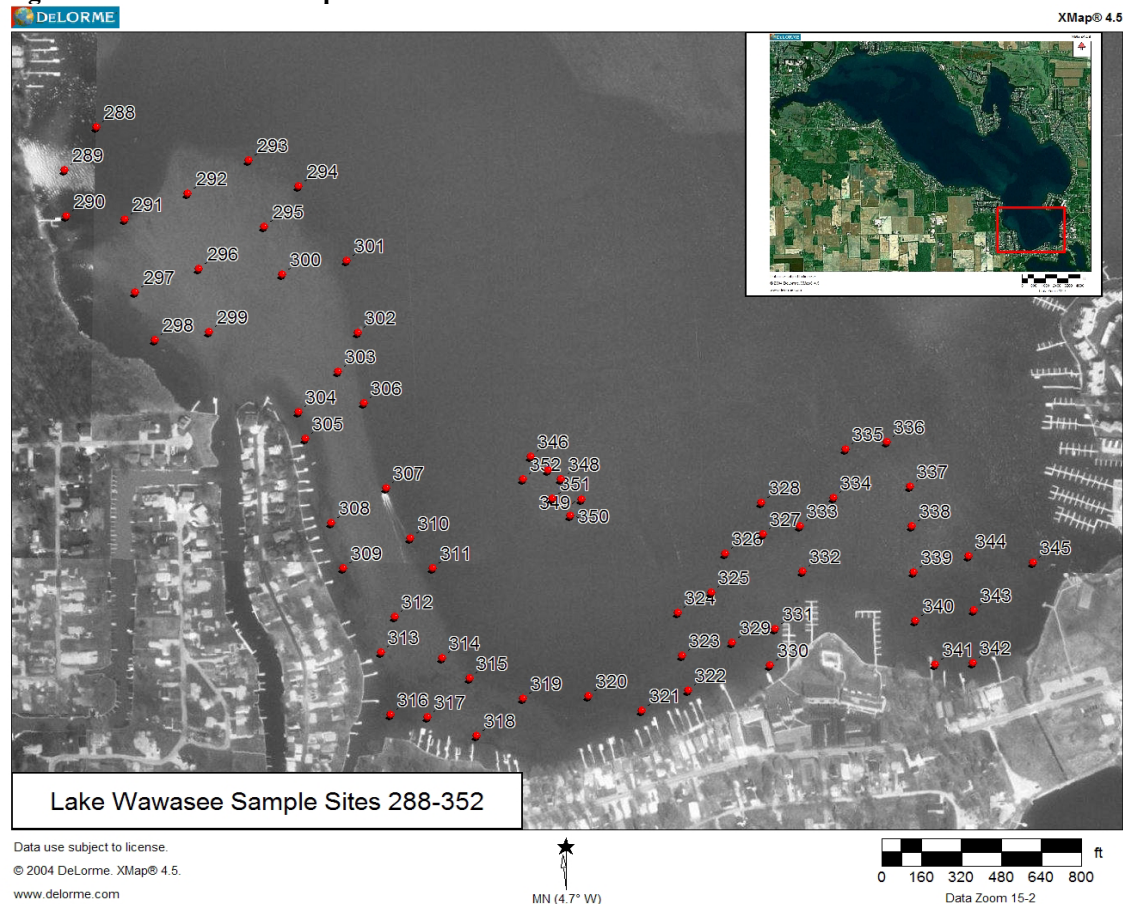
Date:	5/26/05	Littoral sites with plants:			57	Species diversity:			0.80
Littoral depth (ft):	25.0	Number of species:			13	Native diversity:			0.75
Littoral sites:	65	Maximum species/site:			5	Rake diversity:			0.79
Total sites:	65	Mean number species/site:			1.63	Native rake diversity:			0.73
Secchi:	10.0	Mean native species/site:			1.42	*Mean rake score:			1.35
Common Name		Site frequency		Relative density		Mean density			Dominance
Bladderwort		3.1		0.03		1.00			0.6
Chara		61.5		0.74		1.20			14.8
Clasping-leaf		15.4		0.15		1.00			3.1
Coontail		12.3		0.12		1.00			2.5
Curly-leaf		4.6		0.05		1.00			0.9
Eel Grass		6.2		0.06		1.00			1.2
Eurasian milfoil		16.9		0.25		1.45			4.9
Large-leaf		3.1		0.03		1.00			0.6
Northern milfoil		24.6		0.37		1.50			7.4
Waterstargrass		1.5		0.02		1.00			0.3
Whorled milfoil		7.7		0.08		1.00			1.5
Slender Naiad		4.6		0.05		1.00			0.9
Elodea sp		1.5		0.02		1.00			0.3

Table 9: August 2005 South Basin Tier II Summary

## Occurrence and Abundance of Submersed Aquatic Plants

Date: 8/10/205		Littoral sites with plants: 64		Species diversity: 0.88				
Littoral depth (ft): 25.0		Number of species: 17		Native diversity: 0.86				
Littoral sites: 65		Maximum species/site: 5		Rake diversity: 0.86				
Total sites: 65		Mean number species/site: 2.20		Native rake diversity: 0.84				
Secchi: 10.0		Mean native species/site: 2.05		*Mean rake score: 3.38				
Common Name		Site frequency		Relative density		Mean density		Dominance
Chara		60.0		1.43		2.38		28.6
Northern milfoil		23.1		0.80		3.47		16.0
Eel Grass		18.5		0.42		2.25		8.3
Slender Naiad		18.5		0.22		1.17		4.3
Variable P.W.		16.9		0.25		1.45		4.9
Bladderwort		13.8		0.26		1.89		5.2
Eurasian watermilfoil		13.8		0.54		3.89		10.8
Clasping-leaf		10.8		0.32		3.00		6.5
Coontail		10.8		0.43		4.00		8.6
Sago Pondweed		10.8		0.25		2.29		4.9
Whorled milfoil		7.7		0.15		2.00		3.1
Arrowhead sp.		4.6		0.05		1.00		0.9
Illinois P.W.		3.1		0.03		1.00		0.6
Southern Naiad		3.1		0.03		1.00		0.6
Curly-leaf		1.5		0.02		1.00		0.3
Flat-stemmed		1.5		0.02		1.00		0.3
Horned Pondweed		1.5		0.02		1.00		0.3



**Figure 13: South Basin Sample Sites**

Data collected in this area will help serve as an indicator of Eurasian watermilfoil abundance in Lake Wawasee. If chemical treatment becomes necessary in the lake, it will most likely be in this area. The populations of both Eurasian watermilfoil and native plant species in this area will be monitored closely, and any significant changes in this plant community can be identified in the 2006 vegetation surveys. Once the spring survey is complete, the biologists can evaluate the results and determine if chemical treatments are necessary.

The need for chemical treatment in the most heavily infested area of the lake will be based on Eurasian watermilfoil distribution and abundance between sample sites #288 and #352. All of these sites fall within the area of concern and are labeled in the following figure.

### 8.2.3 Mud Lake Survey Results

Mudd Lake is located in the area between Lake Wawasee and Syracuse Lake. There are concerns that the plant community in this area may be adversely affected by disturbance caused by boats. A channel that connects Syracuse and Wawasee runs right down the middle of this lake. This channel is subject to an enormous amount of boat traffic, especially on summer weekends. Not only do many lake residents travel back and forth between Syracuse and Lake Wawasee, but many boaters and fisherman prefer to use the Syracuse Lake public access site to gain access to Lake Wawasee because of congestion at the Wawasee public access site. Other than channels and boating lanes, this lake is almost completely covered with emergent vegetation. Although the only management



recommendation is to track any changes in the Mudd Lake plant community in the future, it was important to sample the lake to gain an overall understanding of its plant community.

Mudd Lake was sampled on August 9, 2005 using the same methods that were used in the Lake Wawasee survey. Many portions of the lake were not navigable, so Tier II sample sites were limited to areas that were accessible by boat. Emergent and submersed plant beds were intermingled with one another in the shallow waters of this lake. For this reason, emergent and submersed plant beds are combined in the following chart.

**Table 10: Mudd Lake Plant Bed Summary**

### **Mudd Lake 2005 Tier I Survey Summary**

Species Abundance by Plant  
Bed #

	#1	#2	#3	#4
<b>Plant Species</b>				
Spatterdock	4	2	4	4
Arrowhead	2		2	2
White Lily	3	1	3	3
Pickeral Weed	1		1	2
Cattail	2		2	2
Watershield	1			
Floating Leaf	1	1		
Purple Loosestrife	2		2	2
Bladderwort		3		
Spiny Naiad		3		
Slender Naiad		3		
Eelgrass		3		
Flat-stemmed Pondweed		2		
Whorled Milfoil		2		
Chara		3		
Richardson's Pondweed		2		
Illinois Pondweed		2		
<b>Total # of Species</b>	<b>8</b>	<b>12</b>	<b>6</b>	<b>6</b>
<b>Size (Acres)</b>	<b>21</b>	<b>10</b>	<b>11.5</b>	<b>4.5</b>

#### **Emergent Bed #1**

Size: 21 acres

Substrate: Silt/Sand

Number of Species: 8

**Description:** This bed dominated the majority of the east end of the lake. It is split down the middle with a small boating lane where more emergent plants were found. Less than 60% of this bed was dominated by spatterdock. Between 21-60% of this bed contained white lily. Six other emergent plant species were found in low abundance.

#### **Emergent Bed #2**

Size: 10 acres

Substrate: Silt/Sand

Number of Species: 12

**Description:** This plant bed covers all of the major boating lanes running throughout Mudd Lake. This is the only bed that could be sampled extensively in the Tier II survey. Emergent vegetation was much less abundant, while nine submersed plant species were found in this bed. Bladderwort, spiny naiad, slender naiad, eelgrass, and chara were all abundant, while the other submersed plant species had abundances well below 20%.

### **Emergent Bed #3**

Size: 11.5 acres

Substrate: Silt/Sand

Number of Species: 6

**Description:** This emergent plant bed is located in very shallow water in the northwest corner of the lake. Spatterdock is dominant in less than 60% of this bed, while white lily was close behind at 21-60%. Other emergent plants in this bed were found in low abundance (<20%).

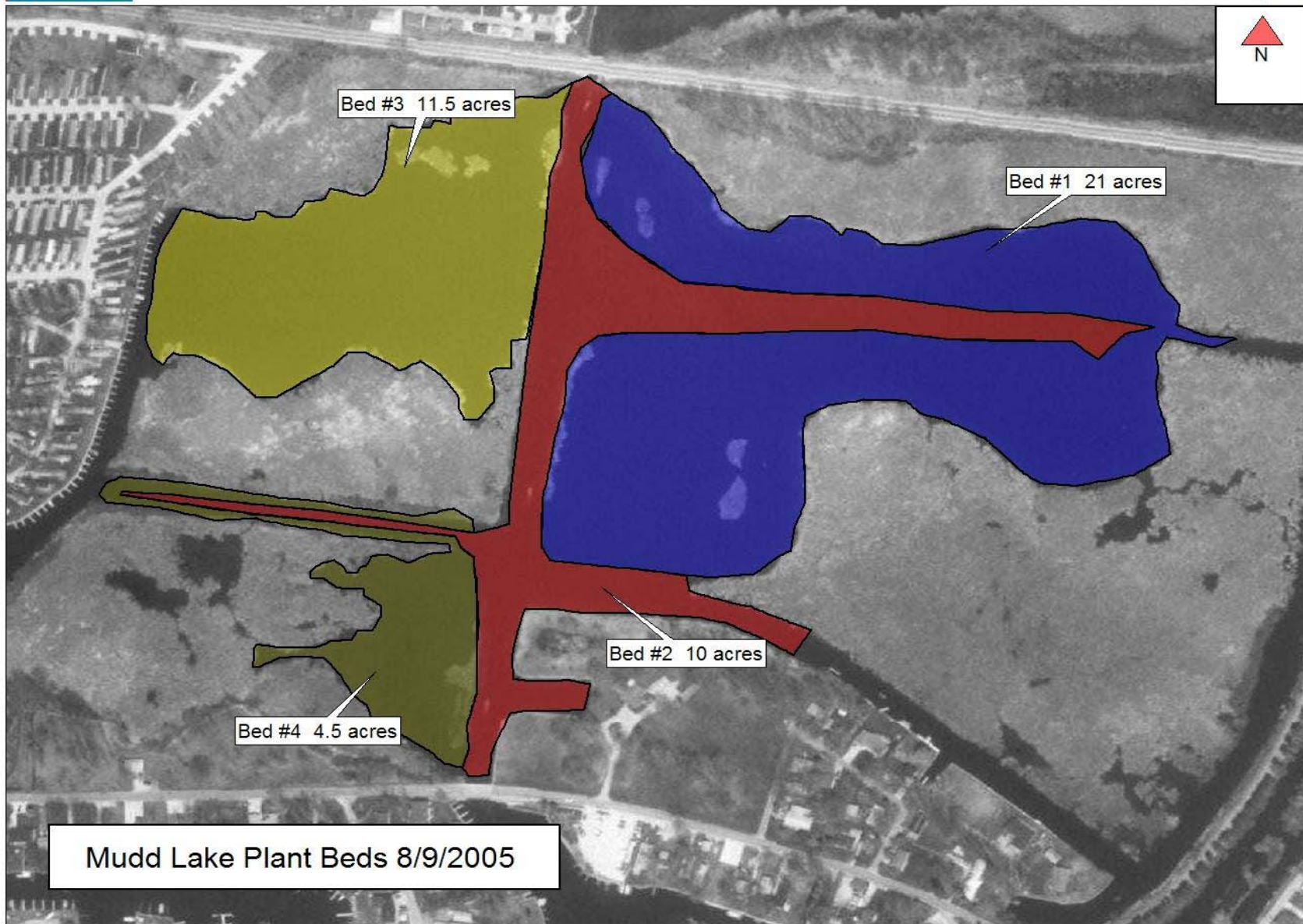
### **Emergent Bed #4**

Size: 4.5

Substrate: Silt/Sand

Number of Species: 6

**Description:** This plant bed is much the same in composition as plant bed #3, but it is separated by a boating lane where emergent plants are rare. Spatterdock is dominant at less than 60%. White lily is next ranging between 21-60%. Four other species of emergent plants were found in low abundance.



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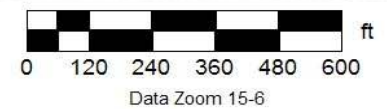
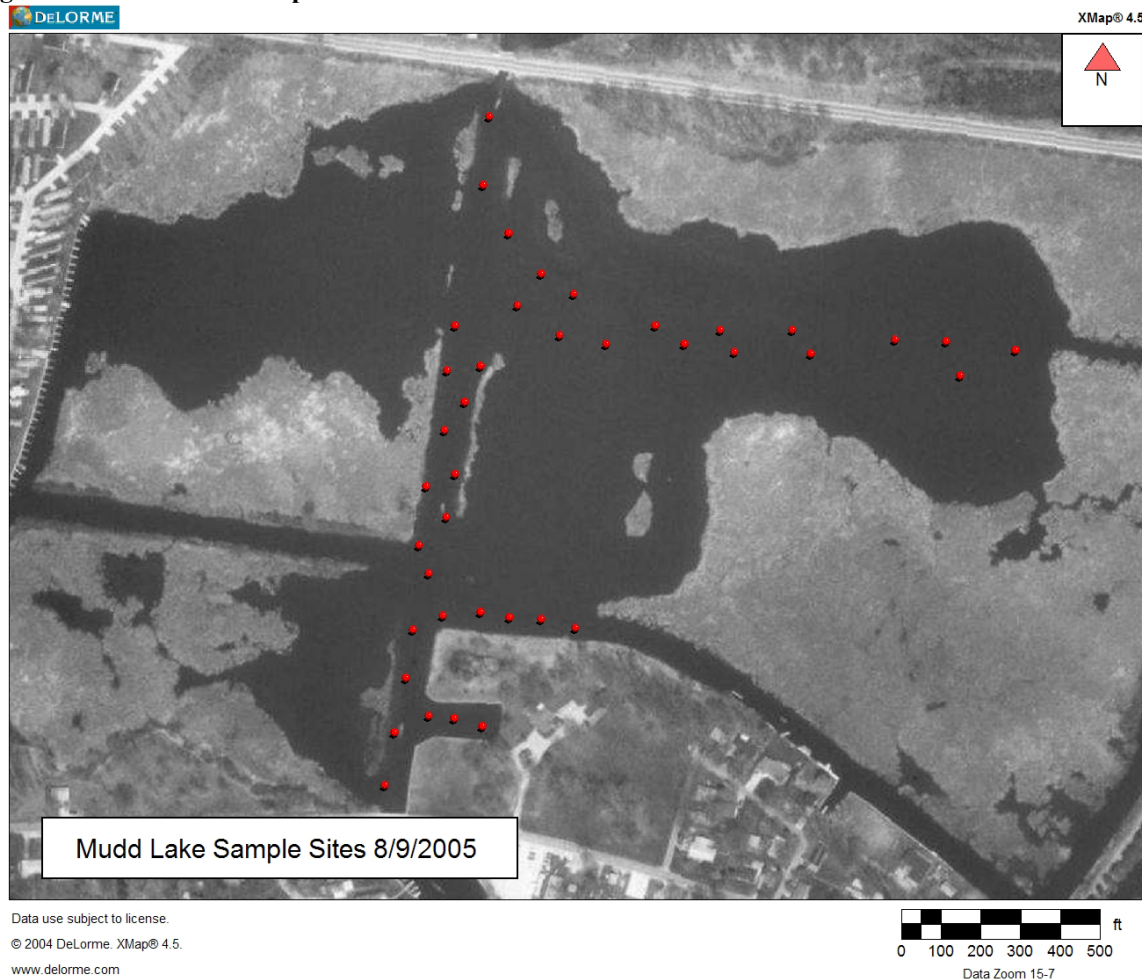


Figure 14: Mudd Lake Plant Beds

## Mudd Lake Tier II Results

The Tier II survey found that Mudd Lake had a diverse plant community even though sampling area was limited by emergent vegetation. The vast majority of the lake cannot be reached by boat. The following map shows that the sample sites were distributed evenly in the navigable portion of the lake.

**Figure 15: Mudd Lake Sample Sites**



The plant community of Mudd Lake is extremely diverse for its size. Seventeen species of submersed plants were collected, which is very comparable to species richness in the main lake. Bladderwort was by far the most frequently collected plant in the survey and was also the most dominant plant as well. Chara and eelgrass both had site frequencies of 40 percent, with chara being the more dominant of the two. Eurasian watermilfoil had a site frequency of only 2.5 % (1 site) and did not appear to be a major problem in Mudd Lake.

**Table 11: Mudd Lake Tier II Summary**

Occurrence and Abundance of Submersed Aquatic Plants						
Date:	8/9/05	Littoral sites with plants:		38	Species diversity:	0.89
Littoral depth (ft):	6.0	Number of species:		16	Native diversity:	0.89
Littoral sites:	40	Maximum species/site:		8	Rake diversity:	0.88
Total sites:	40	Mean number species/site:		3.18	Native rake diversity:	0.88
Secchi:	6.0	Mean native species/site:		3.15	*Mean rake score:	3.35
Common Name	Site frequency	Relative density	Mean density	Dominance		
Bladderwort	65.0	1.15	1.77	23.0		
Chara	40.0	0.85	2.13	17.0		
Eel Grass	40.0	0.58	1.44	11.5		
Whorled Watermilfoil	32.5	0.45	1.38	9.0		
Slender Naiad	25.0	0.43	1.70	8.5		
Arrowhead	22.5	0.30	1.33	6.0		
Spiny Naiad	22.5	0.68	3.00	13.5		
Sago Pondweed	15.0	0.25	1.67	5.0		
Coontail	12.5	0.23	1.80	4.5		
Flat-stemmed Pondweed	12.5	0.13	1.00	2.5		
Clasping-leaf Pondweed	10.0	0.10	1.00	2.0		
Elodea sp	7.5	0.08	1.00	1.5		
Illinois Pondweed	5.0	0.05	1.00	1.0		
Eurasian Watermilfoil	2.5	0.03	1.00	0.5		
Large-leaf Pondweed	2.5	0.03	1.00	0.5		
Variable pondweed	2.5	0.05	2.00	1.0		

### 8.3 Macrophyte Inventory Discussion

Submersed aquatic vegetation covers an estimated 1700 acres, or 55% of Lake Wawasee's total surface area. Significant wetland areas cover approximately 263 acres, both in the lake and on the shoreline of the lake. Of the 1700 acres covered with submersed plants, only 600 of these acres are covered with very dense weed beds. This is just under 205 of the lake's total surface area.

Based upon 2005 survey data, Lake Wawasee has a relatively diverse submersed aquatic plant community when compared with many area lakes. Species richness in Lake Wawasee was high in both surveys with 16 different submersed aquatic plant species collected in the spring survey and 20 species collected in the August survey. Eurasian

watermilfoil is unquestionably present throughout the lake, and although levels are not extremely high in most areas, it is still a species of concern.

As more data is collected in the years to come, long term trends can be identified, and the health of the plant community can be more closely tracked. One of the most obvious trends in the 2005 data was a general increase in submersed plant growth from May to August. Mean rake score increased from 1.38 in the May survey to 2.59 in the fall survey. Species diversity increased slightly from 0.81 in May to 0.88 in August. The average number of species collected at each site rose from 1.56 in May to 2.05 in August.

Individual species showed changes in abundance from May to August as well. Slender naiad had a site frequency of only 3.3 in May but had a site frequency of 18.9 in the August survey. Chara was the most dominant plant in both surveys, with a dominance score of 14.3 in May and a score of 19.6 in August. Distribution and abundance of Eurasian watermilfoil was similar in both surveys. In May Eurasian watermilfoil had a site frequency of 12.8, while in August it had a site frequency of 11.1. Its dominance score was 5.4 in May and 5.5 in August.

Significant wetland areas, especially the larger wetlands in Johnson's Bay and Conklin Bay (emergent beds #3 and #6), are of special concern. Shoreline wetland areas may be deteriorating due to disturbance caused by boat traffic. Idle speed zones have been established in these areas to minimize disturbance from boats.

In summary, the Lake Wawasee plant community is characterized by a diverse native plant community, a moderate abundance of Eurasian watermilfoil, and scarce emergent plant beds that require special protection.

## **9.0 Aquatic Plant Management Alternatives**

At the present time, the health of the plant community in Lake Wawasee is fair. Native plant diversity is high, although Eurasian watermilfoil and Curly leaf pondweed are two invasive species that must be monitored. If Eurasian watermilfoil populations continue to increase, some type of management strategy must be employed to reduce its population. Eurasian watermilfoil is believed to have arrived in North America in the mid 1940's and has spread throughout the east coast to northern Florida and the Midwest. Eurasian watermilfoil spreads by fragmentation and seed dispersal, and it has the ability to over-winter from year to year. Once it is in a lake, it generally becomes the dominant plant species because it forms dense canopies which shade out the native, more beneficial plant species below. There is also increasing evidence that mat forming species like Eurasian watermilfoil and curly leaf pondweed exert significant negative impacts on a broad range of aquatic organisms (Pullman, 1998).

Many management strategies have been used to control Eurasian watermilfoil in Indiana lakes. A management strategy should be chosen based on its selectivity of the pest in question, its long term effectiveness, and its environmental risks. Should a reduction in the Eurasian watermilfoil population become necessary, a management option should be chosen that can effectively control the Eurasian watermilfoil with little or no environmental risk, while causing no harm to native plants or fish species.

## 9.1 No Action

If no action is taken, the Eurasian watermilfoil abundance may remain stable, or it may increase from year to year. Eurasian watermilfoil grows by fragmentation, meaning that if the plant is cut, the fragment has the ability to form an entirely new plant. Eurasian watermilfoil also over-winters as an adult plant so new generations are generated each season. These reproductive characteristics cause milfoil beds to become more dense over time, creating a monoculture as it eliminates more and more native species from the lake. Lake Wawasee has the advantage of a well established, diverse native plant community, as well as high water quality. These factors have undoubtedly kept the Eurasian watermilfoil from becoming totally dominant, as has been observed in numerous lakes in the Midwest. If no action is taken to reduce the population, additional plant surveys will be essential to ensure the Eurasian population does not increase in the lake.

## 9.2 Institutional-Protection of Beneficial Vegetation

Lake users can play an important role in the protection of beneficial aquatic vegetation. Aquatic invasive species often gain a foothold in an ecosystem in areas disturbed by human activity or natural processes. In many cases, boating may be restricted in certain areas of a lake to prevent harm to native plants, especially many emergent species. Boating lanes may be established throughout areas of emergent vegetations, and protected ecological zones may be created to prevent erosion of off shoreline vegetation caused by intense wave action from boating activities. The IDNR has established ecological zones in Johnson's Bay and Conklin Bay. Shallow areas of a lake may also be marked with buoys to prevent injury to boaters and water skiers. It is important to obey boating restrictions to protect beneficial plant species and even prevent personal injury.

A healthy aquatic plant community is absolutely essential for the maintenance of a stable, diverse ecosystem. Aquatic plants provide habitat for plankton, insects, crustaceans, fish, and amphibians. They take nutrients like phosphorus and nitrogen out of the water column, increase water clarity, prevent harmful algal blooms, produce oxygen and provide food for waterfowl. Aquatic plants can even remove pollutants from contaminated water and prevent the suspension of particulate matter by stabilizing sediment and preventing erosion from wave action or current.

The LARE aquatic vegetation management program recognizes the importance of beneficial aquatic vegetation, and its protection is a top priority. The most basic goal for the LARE aquatic vegetation program is to maintain healthy aquatic ecosystems by maintaining or improving biodiversity in Indiana lakes. The purpose of conducting aquatic vegetation surveys is to document the overall health of plant communities and identify any ecosystem whose stability is threatened by invasive plant species.

Once a problem area is identified, a management strategy must be formulated that directly impacts the aquatic plant community in a positive way. While eradicating invasive plants is a major component of many management strategies, it is important to note the ultimate goal is not to eradicate aquatic vegetation but to protect beneficial vegetation and lake ecosystems.



## 9.3 Environmental Manipulation

Draw down of the lake water level is one option that may help the Eurasian watermilfoil problem. Lower water levels expose the Eurasian watermilfoil roots to freezing and thawing, which may kill milfoil root systems. However, a lake draw down will not only kill Eurasian watermilfoil but native plants as well. Also, reducing the lake level would make new areas of the lake available for vegetative growth, and Eurasian watermilfoil may have an advantage in the colonization of these new areas if it is not eradicated prior to the lake draw down.

### 9.3.1 Nutrient Reduction

An overabundance of nutrients can greatly increase the possibility that an invasive species will proliferate in a body of water. Limiting factors for plant growth include light, lake morphometry and depth, substrate, and the availability of nutrients like phosphorus and nitrogen. While lake morphometry is most highly correlated with plant biomass, the availability of phosphorus and nitrogen have a tremendous impact on the amount of plant growth in a body of water. If the vast majority of phosphorus in a system is tied up in plant matter, it may be difficult for an invasive species to gain a foothold and spread rapidly in the lake. If phosphorus is constantly being added to the system and is readily available in the water, invasive species can use this nutrient excess and take over a system within a few growing seasons.

Phosphorus and nitrogen are added to aquatic systems by many natural sources, such as



the decomposition of plant material and animal waste. Human activity, however, is often responsible for excessive phosphorus loading that contributes to blue-green algal blooms, overabundant vegetation growth, and a general decline in water quality. Major

contributions of excess phosphorus come from sources such as septic system inputs, agricultural runoff, storm water drainage, lawn fertilizer applications, and improper disposal of grass clippings and tree leaves. Owners of lake front property can significantly reduce the amount of phosphorus entering the lake by taking actions outlined in the public education section.



## 9.4 Mechanical Controls

### 9.4.1 Mechanical Cutting and Harvesting



[www.cleanlake.com](http://www.cleanlake.com)

Mechanical harvesting uses a large machine to cut and collect unwanted aquatic plants. These machines pick up the cut weeds but leave small fragments that will have the ability to re-grow. Also, after an area is harvested the Eurasian watermilfoil generally re-grows, causing the native plants to be shaded out again. Mechanical harvesting is also not selective in its control. The

harvesting will cut the native plant species as well as the exotics if both are present in the same area. For these reasons, mechanical harvesting is not recommended. Harvesting can be accomplished by individual owners around their dock areas. A lake property owner can legally harvest a 625 square foot area. (25 feet by 25 feet).

## 9.5 Manual Controls

### 9.5.1 Hand Pulling, Cutting, Raking



[www.ecy.wa.gov](http://www.ecy.wa.gov)

Manual controls such as hand pulling, cutting, and raking can be effective ways to control unwanted plants in certain situations. In very shallow clear water, small areas of vegetation can be identified and cleared effectively by hand. Large areas of vegetation, especially those in deeper water, can be extremely difficult to control using these methods. Many of the harvested weeds will break apart, leaving the root system in the lake bottom. Failure to

remove root structures will result in re-growth.

Plants that possess the ability to reproduce through fragmentation can seldom be effectively controlled by these methods if they are distributed throughout a lake. Identifying every area of infestation would be difficult, as would harvesting the plants without causing fragmentation of individual plants. Any plant fragments not removed from the water can form new plants, meaning that hand pulling and cutting can facilitate the spread of the unwanted plant species.

## 9.5.2 Bottom Barriers



[www.ecy.wa.gov](http://www.ecy.wa.gov)

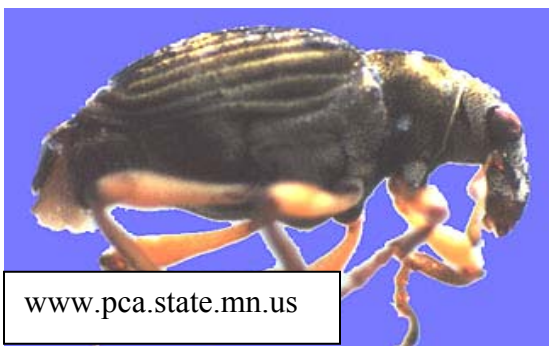
Bottom Barriers prevent the growth of aquatic plants by lining the bottom of a lake or pond with a material that prohibits light from reaching the lake bottom, which is difficult for plants to penetrate. Many times, plastic or concrete barriers are used to prevent the growth of aquatic vegetation during construction of a lake or pond. This form of control is best implemented during construction of a new pond. Placing a bottom

barrier in an existing lake would involve significant challenges and would be extremely expensive. A draw down of the lake may be necessary to install the barrier, but if the lake level is not regulated by control structures, this can be almost impossible. For a large lake, material costs alone would be enormous.

Once in place, the barrier would prevent not only invasive plant growth but native plant growth as well, destabilizing the lake ecosystem and having a negative impact on insect and fish communities. Sediment would gradually accumulate on top of the barrier, and aquatic plant growth would return as plants begin to take root in the sediment on top of the barrier.

## 9.6 Biological Controls

### 9.6.1 Water Milfoil Weevil



[www.pca.state.mn.us](http://www.pca.state.mn.us)

The water milfoil weevil is a native North American insect that consumes Eurasian watermilfoil and northern milfoil. The weevil was discovered after a decline in the Eurasian watermilfoil population was observed in Brownington Pond, Vermont (Creed and Sheldon, 1993). The milfoil weevil burrows down into the stem of the plant and consumes the tissue of the plant. Holes in the milfoil stem bored by weevil

larvae allow disease to enter the plant. These same holes also cause a release of the plant's gases, which reduces buoyancy and causes the plant to sink (Creed et. Al. 1992).

Studies conducted to evaluate the effectiveness of the water milfoil weevil have not yielded consistent results. Factors influencing the weevil's success or failure in a body of water are not well documented. In 2003, Scribailo and Alix conducted a weevil test on Round Lake in Indiana and found no conclusive evidence that the Eurasian watermilfoil populations were reduced.

## 9.6.2 Grass Carp



[www.tpwd.state.tx.us](http://www.tpwd.state.tx.us)

The Asian grass carp or white amur (*Ctenopharyngodon idella*) is an herbivorous fish that is native to eastern Russia and China. This fish has been introduced into the U.S. to help control aquatic vegetation. To prevent their uncontrolled proliferation, all fish

stocked in Indiana must be triploid, meaning that they cannot reproduce. Stocking is restricted to privately owned bodies of water, and suppliers must obtain a special permit from the IDNR. Grass carp are completely vegetarian, feeding on many species of submersed plants, along with some floating plants such as duckweed. Hydrilla, a highly invasive plant found in many southern states is a preferred food of grass carp, and efforts to control hydrilla with grass carp have been successful.

According to the Aquatic Ecosystem Restoration Foundation, grass carp avoid Eurasian watermilfoil and show strong preferences for many native plants along with hydrilla. The success of grass carp stockings is highly dependant upon the food sources available to the fish. When Eurasian watermilfoil occurs along with native plant populations, grass carp are not recommended.

## 9.7 Chemical Controls

### 9.7.1 Aquatic Herbicides

There are two major categories of aquatic herbicides: contact and systemic herbicides. Contact herbicides are used best to control the majority of the weeds close to shore, around piers, and in man-made channels. Reward (active ingredient: diquat) and Aquathal (active ingredient: endothal) are two examples of contact herbicides. Contact herbicides would not be a wise choice for a whole lake treatment because of their lack of selectivity and their inability to eliminate the root systems of treated plants. These characteristics could result in unnecessary damage to native species, as well as greater potential for the re-infestation of Eurasian watermilfoil.

Systemic herbicides are absorbed by the plant and transported to the root systems where they eliminate both the roots and the plant. Examples of systemic herbicides are Sonar and Avast (active ingredient: fluridone), Navigate, Aqua Kleen, DMA4 (active ingredient 2, 4-D), and Renovate (active ingredient: triclopyr). All of these chemicals effectively kill Eurasian watermilfoil plants and roots. Based on the author's experience and other lake managers in the Midwest, whole lake treatments using fluridone are the most effective way to control Eurasian water milfoil in lakes that have become severely infested. Fluridone can be applied at low rates to control the Eurasian watermilfoil while causing very little harm to the majority of the native weed species present in the lake.

Triclopyr and 2, 4-D are both root control herbicides which can to be used for spot treatments in small areas of Eurasian watermilfoil infestation, while the whole lake must be treated if fluridone is used. The major difference between 2, 4-D and triclopyr is that triclopyr may have the ability to control the Eurasian watermilfoil in select areas longer than 2,4-D. Renovate (triclopyr) has only been available for use for the past three seasons, and the ability of Renovate to provide more long term control of Eurasian

watermilfoil than 2,4-D in spot treatment situations is still being documented. 2, 4-D is less expensive to use, but if triclopyr continues to show better long term control in treated areas it may become the most cost effective long term investment.

The public's primary concern with the use of aquatic herbicides is safety. Every chemical registered for aquatic applications has undergone extensive testing prior to becoming available for use. These tests demonstrate that when these herbicides are applied properly at labeled rates, they are safe for humans and will not cause any adverse environmental effects.

## 10.0 Public Involvement

The following is a summary of the public questionnaire data received from input at public meetings. Questionnaires were handed out to all in attendance at the public meeting. Data was compiled and the original questionnaire was used to show a summary of all responses.

**Figure 16: Public Involvement**

(6 participants)

Lake Use Survey

Lake name Wawasee

Are you a lake property owner? Yes 6 No 0

Are you currently a member of your lake association? Yes 6 No 0

How many years have you been at the lake?

2 or less - 0  
 2 - 5 years - 0  
 5-10 years - 1  
 Over 10 years - 5

How do you use the lake (mark all that apply)

6 Swimming 3 Irrigation  
6 Boating 0 Drinking water  
3 Fishing 1 Other skiing

Do you have aquatic plants at your shoreline in nuisance quantities? Yes 3 No 3

Do you currently participate in a weed control project on the lake? Yes 5 No 1

Does aquatic vegetation interfere with your use or enjoyment of the lake? Yes 3 No 3

Does the level of vegetation in the lake affect your property values? Yes 3 No 2

Are you in favor of continuing efforts to control vegetation on the lake? Yes 6 No 0

Are you aware that the LARE funds will only apply to work controlling invasive exotic species, and more work may need to be privately funded? Yes 4 No 2

Mark any of these you think are problems on your lake:

5 Too many boats access the lake  
4 Use of jet skis on the lake  
2 Too much fishing  
0 Fish population problem  
1 Dredging needed  
2 Overuse by nonresidents  
2 Too many aquatic plants  
0 Not enough aquatic plants  
1 Poor water quality  
4 Pier/funneling problem

Please add any comments:

a reasonable speed limit would decrease excess  
boat speed and noise.



## 11.0 Public Education

Lake residents play an important role in establishing and maintaining a healthy lake community. Lake association meetings and newsletters are excellent avenues through which information about management practices on Lake Wawasee can be distributed. These meetings can also help to inform the public about practical steps that they can take to improve Lake Wawasee. The following information is designed to give practical suggestions on ways that lake residents can reduce nutrient loading and improve the Lake Wawasee ecosystem.

1. **Ensure that all existing homes be connected to a properly maintained lake wide sewer system if possible.** Many older homes possess septic systems without proper filter beds. Some systems may have significant leaks, while some may drain into the lake. Sewage leaks add tremendous amounts of nutrients to the water, along with harmful bacteria.
2. **Limit lawn fertilizer use in areas where runoff will enter the lake.** If a fertilizer application must be applied, avoid spreading fertilizer directly into the lake, on sidewalks, or sea walls where it will wash into the lake. Try to avoid applying fertilizer within 30 feet of the lakeshore.
3. **Work with farmers within the lake catchments to increase proper filtration and drainage of agricultural land before runoff reaches the lake.** The Indiana state government offers incentives for farmers to address soil and water concerns through the U.S. Department of Agriculture. The Indiana Conservation Reserve Program (CRP) provides technical and financial aid to reduce soil erosion, reduce sediment in lakes and streams, and improve overall water quality. Farmers owning highly erodible land or property adjacent to tributary streams or lakes may be eligible for funding that can increase water quality significantly. Further information can be found at [www.in.nrcs.usda.gov/programs/CRP/crphomepage.html](http://www.in.nrcs.usda.gov/programs/CRP/crphomepage.html) or by contacting the following address.  
 Indiana NRCS  
 6013 Lakeside Boulevard  
 Indianapolis, Indiana 46278-2933  
 Phone: (317) 290-3200  
 FAX: (317) 290-3225
4. **Avoid blowing grass clippings and tree leaves into the lake.** Many pond owners know that grass clippings blown into a pond can turn into a floating mat of algae in only a few days. This occurs because cut and decaying vegetation rapidly releases nutrients into the water.
5. **Prevent or reduce urban and industrial runoff flowing directly into the lake.** Urban runoff can be one of the most detrimental factors influencing water quality. Not only are nutrients and sediment carried to lakes through storm sewers but harmful contaminants as well. Oil, antifreeze, gasoline, road salt, and other pollutants are washed from pavement and can all end up harming a lake's ecosystem.

The following are practical steps recommended by the United States Environmental Protection Agency to reduce urban runoff:

- a) Protect areas that provide important water quality benefits or are particularly susceptible to erosion or sediment loss.
- b) Limit land disturbance such as clearing and grading and cut fill to reduce erosion and sediment loss.
- c) Limit disturbance of natural drainage features and vegetation.
- d) Place bridge structures so that sensitive and valuable aquatic ecosystems are protected.
- e) Prepare and implement an approved erosion control plan.
- f) Ensure proper storage and disposal of toxic material.
- g) Incorporate pollution prevention into operation and maintenance procedures to reduce pollutant loadings to surface runoff.
- h) Develop and implement runoff pollution controls for existing road systems to reduce pollutant concentrations and volumes.

Further information about urban runoff in Indiana can be obtained by contacting the EPA Region 5 National Pollution Discharge Elimination System Storm Water Coordinator by calling (312) 886-6100.

6. **Establish ecological zones to protect existing wetlands and emergent vegetation from turbulence caused by boats.** Wetlands not only filter water, but they also stabilize shoreline areas that would otherwise be highly erodible. Submersed and emergent vegetation can be eliminated by heavy wave action, which destabilizes the shoreline and reduces the lake's natural defense against sediment and nutrient loading. It is extremely important to make sure that existing wetlands remain intact to aid in the natural water purification process. If possible, lake associations should identify significant wetland areas and work with the IDNR to protect them from drainage and disruption.

## 12.0 Integrated Treatment Action Strategy

Aquatic vegetation surveys will be conducted in the spring of 2006 to determine if chemical treatment will be necessary to reduce the Eurasian watermilfoil population in Lake Wawasee. If these surveys find that the Eurasian watermilfoil population changes little from the 2005 surveys, then no chemical treatment may be necessary. If the abundance of Eurasian watermilfoil increases, then chemical treatment will be needed to reduce the Eurasian watermilfoil population in the most heavily infested areas. One area of special concern is the deep weed beds in the extreme southern corner of the lake, just west of the IDNR public access site. This area was the most heavily infested area of the lake.

Data analysis summaries have been prepared specifically for this area. An identical summary will be prepared following the completion of the spring 2006 Tier II survey of Lake Wawasee. Results from the 2006 spring survey will be compared with data from the 2005 surveys to determine if chemical treatment is necessary. Another data summary of this area will be prepared following the late season 2006 Tier II survey, regardless of whether this area was chemically treated. These summaries will help identify changes in the plant community in this area in the years to come.

## 13.0 Project Budget

The following treatment costs are estimated based on lake size, average depth, chemical and application costs, as well as LARE survey requirements.

### 2006

Early season aquatic vegetation survey

Late Season vegetation survey and plan update costs will depend upon new IDNR requirements	Approximately    \$13,500
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Any herbicide applications will depend on the results of the surveys.

### 2007

Early season aquatic vegetation survey

Late Season vegetation survey and plan update	Approximately    \$13,500
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Any herbicide applications will depend on the results of the surveys.



## 14.0 Monitoring and Plan Update Procedures

As the action plan is implemented, aquatic vegetation surveys will help to monitor the effectiveness of the management strategy. The abundance and distribution of Eurasian watermilfoil will be recorded using the Tier I and Tier II sampling protocols outlined in this report.

After the spring 2006 vegetation survey, any changes in the distribution and abundance of Eurasian watermilfoil will be identified. These results will be used to determine if any chemical treatments are necessary. If chemical treatments are necessary, the new survey data can be used to determine if treatments were successful. The surveys can also document the re-colonization of native plants in areas of previous Eurasian watermilfoil infestation. The new data analysis results will be added to the current lake management plan. This will provide property owners, applicators, and the IDNR with detailed records describing the changes in the plant community of Lake Wawasee.

In the years that follow, additional surveys should be conducted to determine how the Eurasian watermilfoil population is reacting to the management strategy over a long period of time. These surveys will provide a basis for evaluation of the management strategy and can be presented to the public should the need arise to modify the management strategy. They will also serve to keep the public interested and informed about management practices at the lake so they will be motivated and equipped to actively participate in the conservation of the Lake Wawasee ecosystem.

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## 16.0 Appendices

### 16.1 Pesticide Use Restrictions Summary:

The following table was produced by Purdue University and included in the Professional Aquatic Applicators Training Manual. It gives a summary of water use restrictions on all major chemicals available for use in the aquatics market.

**Figure 17: Pesticide Use Restrictitons**

	Human			Animal	Irrigation		
	Drinking	Swimming	Fish Consumption	Drinking	Turf	Forage	Food Crops
----- waiting period, in days -----							
Copper Chelate	0	0 <sup>a</sup>	0	0	0	0	0
Copper Sulfate	0	0 <sup>a</sup>	0	0	0	0	0
Diquat	1-3	0 <sup>a</sup>	0	1	1-3	1-3	5
Endothall (granular) <sup>b</sup>	7	0 <sup>a</sup>	3	0	7	7	7
Endothall (liquid) <sup>b</sup>	7-25	0 <sup>a</sup>	3	7-25	7-25 <sup>d</sup>	7-25	7-25
Endothall 191 (granular) <sup>c</sup>	7-25	0 <sup>a</sup>	3	7-25	7-25	7-25	7-25
Endothall 191 (liquid) <sup>c</sup>	7-25	0 <sup>a</sup>	3	7-25	7-25	7-25	7-25
Fluridone	0 <sup>e</sup>	0 <sup>a</sup>	0	0	7-30	7-30	7-30
Glyphosate	0 <sup>e</sup>	0 <sup>a</sup>	0	0	0	0	0
2,4-D (granular)	*	0 <sup>a</sup>	0	*	*	*	*

<sup>a</sup>Although this compound has no waiting period for swimming, it is always advisable to wait 24 hours before permitting swimming in the direct area of treatment.

<sup>b</sup>Trade name is Aquathol®.

<sup>c</sup>Trade name is Hydrothol®.

<sup>d</sup>May be used for sprinkling bent grass immediately.

<sup>e</sup>Do not apply this product within 1/4 (fluridone) to 1/2 (glyphosate) mile upstream of potable water intakes.

\*Do not use treated water for domestic purposes, livestock watering (2,4-D, dairy animals only), or irrigation.

## 16.2 State Regulations for Aquatic Plant Management

The following information is found on the IDNR website and outlines general regulations for the management of aquatic plants in public waters.

### AQUATIC PLANT CONTROL PERMIT REGULATIONS

Indiana Department of Natural Resources

Note: In addition to a permit from IDNR, public water supplies cannot be treated without prior written approval from the IDEM Drinking Water Section. **Amended state statute adds biological and mechanical control (use of weed harvesters) to the permit requirements, reduces the area allowed for treatment without a permit to 625 sq ft, and updates the reference to IDEM. These changes become effective on July 1, 2002.**

#### Chapter 9. Regulation of Fishing

##### IC 14-22-9-10

Sec. 10. (a) This section does not apply to the following:

- (1) A privately owned lake, farm pond, or public or private drainage ditch.
- (2) A landowner or tenant adjacent to public waters or boundary waters of the state, who chemically, mechanically, or physically controls aquatic vegetation in the immediate vicinity of a boat landing or bathing beach on or adjacent to the real property of the landowner or tenant if the following conditions exist:
  - (A) The area where vegetation is to be controlled does not exceed:
    - (i) twenty-five (25) feet along the legally established, average, or normal shoreline;
    - (ii) a water depth of six (6) feet; and
    - (iii) a total surface area of six hundred twenty-five (625) square feet.
  - (B) Control of vegetation does not occur in a public waterway of the state.
- (b) A person may not chemically, mechanically, physically, or biologically control aquatic vegetation in the public waters or boundary waters of the state without a permit issued by the department. All procedures to control aquatic vegetation under this section shall be conducted in accordance with rules adopted by the department under IC 4-22-2.
- (c) Upon receipt of an application for a permit to control aquatic vegetation and the payment of a fee of five dollars (\$5), the department may issue a permit to the applicant. However, if the aquatic vegetation proposed to be controlled is present in a public water supply, the department may not, without prior written approval from the department of environmental management, approve a permit for control of the aquatic vegetation.
- (d) This section does not do any of the following:
  - (1) Act as a bar to a suit or cause of action by a person or governmental agency.
  - (2) Relieve the permittee from liability, rules, restrictions, or permits that may be required of the permittee by any other governmental agency.
  - (3) Affect water pollution control laws (as defined in IC 13-11-2-261) and the rules adopted under water pollution control laws (as defined in IC 13-11-2-261).

As added by P.L.1-1995, SEC.15. Amended by P.L.1-1996, SEC.64.

#### 312 IAC 9-10-3 Aquatic vegetation control permits

Authority: IC 14-22-2-6; IC 14-22-9-10

Affected: IC 14-22-9-10

- Sec. 3. (a) Except as provided under IC 14-22-9-10(a), a person shall obtain a permit under this section before applying a substance to waters of this state to seek aquatic vegetation control.
- (b) An application for an aquatic vegetation control permit shall be made on a departmental form and must include the following information:
    - (1) The common name of the plants to be controlled.
    - (2) The acreage to be treated.
    - (3) The maximum depth of the water where plants are to be treated.
    - (4) The name and amount of the chemical to be used.
  - (c) A permit issued under this section is limited to the terms of the application and to conditions imposed on the permit by the department.
  - (d) Five (5) days before the application of a substance permitted under this section, the permit

holder must post clearly, visible signs at the treatment area indicating the substance that will be applied and what precautions should be taken.

(e) A permit issued under this section is void if the waters to be treated are supplied to the public by a private company or governmental agency. (*Natural Resources Commission*; 312

## 16.3 Resources for Aquatic Management

In addition to the LARE Program, there are many other sources of potential funding to help improve the quality of Indiana Lakes. Many government agencies assist in projects designed to improve environmental quality.

The USDA has many programs to assist environmental improvement. More information on the following programs can be found at [www.usda.gov](http://www.usda.gov).

Watershed Protection and Flood Prevention Program (USDA)

Conservation Reserve Program (USDA)

Wetlands Reserve Program (USDA)

Grassland Reserve Program (USDA)

Wildlife Habitat Incentive Program (USDA)

Small Watershed Rehabilitation Program (USDA)

The following programs are offered by the U.S. Fish and Wildlife Service. More information about the Fish and Wildlife service can be found at [www.fws.gov](http://www.fws.gov)

Partners for Fish and Wildlife Program (U.S. Fish and Wildlife Service)

Bring Back the Natives Program ( U.S. Fish and Wildlife Service)

Native Plant Conservation Program (U.S. Fish and Wildlife Service)

The Environmental Protection Agency, the Indiana Department of Environmental Management, and the U.S. Forest Service also have numerous programs for funding. A few of these are listed below. More information can be found at [www.in.gov/idem](http://www.in.gov/idem) and [www.fs.fed.us/](http://www.fs.fed.us/)

U.S. Environmental Protection Agency Environmental Education Program (EPA)

NPDES Related State Program Grants (IDEM)

Community Forestry Grant Program (U.S. Forest Service)

## 16.4 Common Aquatic Plants of Indiana

The following appendix was compiled using information found in the 5<sup>th</sup> edition of *How to Identify Water Weeds and Algae*, edited by James C. Schmidt and James R. Kannenberg. All pictures, with the exception of Illinois pondweed and northern milfoil were taken from the *Category 5 Aquatic Pest Control Management Manual*, written by Dr. Carole Lembi, Head of the Department of Botany and Plant Pathology at Purdue University.

### American Pondweed



Scientific name: *Potamogeton americanus*

Classification: Native to Indiana

Distribution: Common throughout the U.S.

**Description:** American pondweed can be identified by its oval shaped leaves floating on the top of the water. The base of each leaf tapers to a very long petiole that connects the leaf with the stem of the plant. Plant leaves are arranged alternately on the stem and leaves are usually sparsely scattered.

### Chara



Scientific name: *Chara sp.*

Classification: Native to Indiana

Distribution: Extremely common worldwide. Usually found in hard water.

**Description:** Chara is often mistaken for a vascular plant, but it is actually an advanced form of algae. It can be gray, green or yellow in color and is usually forms extremely dense beds that may cover an entire lake. It can be identified by its distinct musky odor and calcium deposits on the algae's surface make it feel bristly to the touch. It possesses leaf-like structures that are whorled around the hollow stem, and it attaches itself to the lake bottom, although it has no actual roots. It usually grows in shallow, clear water.



## Coontail



Scientific name: *Ceratophyllum demersum*

Classification: Native to Indiana

Distribution: Common throughout the U.S., usually in hard water.

**Description:** Coontail plants are submersed and have no roots, though they appear to be attached to the lake bottom when viewed from above the surface of the water. The free-floating nature of coontail allows it to colonize new areas of a lake quickly, and it often times forms

extremely dense weed beds where sufficient light and nutrients are available. Coontail has dark green leaves arranged in whorls around the stem and usually grows in long, bushy strands resembling evergreen trees beneath the surface of the water. Coontail's structure is very similar to Eurasian watermilfoil but coontail has forked leaves, which distinguishes it from the feather-like projections of milfoil leaves.

## Curley Leaf Pondweed



Scientific name: *Potamogeton crispus*

Classification: Exotic to Indiana

Distribution: Found throughout the U.S. in fresh and brackish water.

**Description:** Curley leaf pondweed usually grows and spreads rapidly in early spring and begins to die out by midsummer as water temperatures approach 70 degrees Fahrenheit. Curley leaf has extremely thin, membranous leaves arranged alternately on the stem with small teeth-like projections visible along the edge of each leaf. A

reproductive spike may be seen protruding from the surface of the water. Curley leaf pondweed may also leave small reproductive structures called turions in the sediment on the lake bottom that can lie dormant throughout the winter and then sprout when spring arrives.

## Eel Grass (Wild Celery)



Scientific name: *Vallisneria Americana*

Classification: Native to Indiana

Distribution: Found from the Great Plains to the East Coast of the U.S.

**Description:** Eel grass has tufts of ribbon-like leaves with a horizontal stem embedded in the sediment connecting each tuft. This native plant grows thick weed beds anchored in the mud by roots. These dense beds often shade out other forms of weeds and provide excellent escape cover for small fish. The flowers of this plant are visible in late summer and sit on the top of a coiled structure protruding to the surface. This plant is found in both lakes and river, but is seldom found in stagnant systems. It is considered an extremely valuable plant to aquatic ecosystems.

## Elodea



Scientific Name: *Elodea Canadensis*

Classification: Native to Indiana

Distribution: Common throughout the north and north central united states. Its ranges extends as far south as northern Tennessee.

**Description:** Elodea grows in long strands resembling milfoil, but its leaves are broad and oval shaped. Leaves are arranged in whorls with three leaves usually occurring at each node. Leaves near the tip of the plant are closely packed together, with the distance between nodes increasing further down the stem.

## Eurasian watermilfoil



Scientific Name: *Microphyllum spicatum*

Classification: Exotic in Indiana

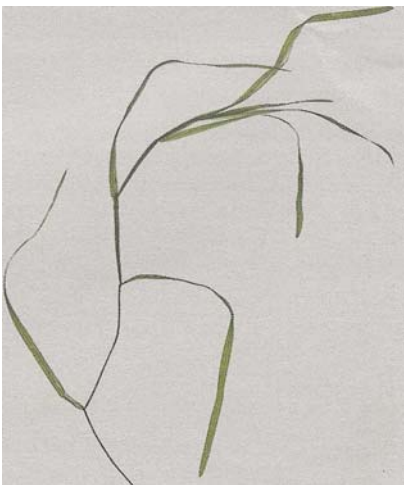
Distribution: Common in the Midwest and Eastern U.S. Also spreading along the Pacific coast

**Description:** This extremely aggressive and extremely destructive plant has leaves in whorls of 4 around a reddish stalk. This plant grows rapidly and can reach lengths of over 10 feet. This plant has the ability to over winter, meaning it can lie dormant during the winter months instead of dying out

completely each year. This gives it a distinct advantage over many native species, as it competes for sunlight in early spring. The dormant milfoil plants reach the surface much faster than the native plants sprouting from the lake bottom. This enables the Eurasian watermilfoil to shade out other plants and form the dense beds that choke the littoral zone of many lakes.

A reproductive process called fragmentation aids the rapid dispersion of Eurasian watermilfoil. If a milfoil plant is damaged and some fragments are removed from the macrophyte, each small piece of the plant has the ability to grow roots and create a new milfoil plant. Eurasian watermilfoil is considered one of the most dangerous aquatic nuisance species because of its ability to rapidly disrupt and destroy lake ecosystems.

## Flat-stemmed Pondweed



Scientific Name: *Potamogeton zosteriformis*

Classification: Native to Indiana

Distribution: Common throughout the northern half of the U.S.

**Description:** the most noticeable characteristic is the large, very flat stem. It cannot be rolled between the fingers easily. The ribbon-like leaves extend from the stem toward the surface of the water.

## Illinois Pondweed



[www.wvu.edu](http://www.wvu.edu)

Scientific name: *Potamogeton illinoensis*

Classification: Native to Indiana

Distribution: Very widespread and very common throughout the upper Midwest and the U.S

**Description:** Illinois pondweed is common in Indiana, especially in the northern third of the state. This leafy weed has leaves with very broad bases that extend three-fourths of the way around the stem. The upper part of its slender stem is usually branched and very leafy.

## Large Leaf Pondweed

Scientific name: *Potamogeton amplifolius*

Classification: Native to Indiana

Distribution: Common throughout the upper Midwest and the northern United States in hard water.

**Description:** This plant has both submersed and floating leaves. The floating leaves are oval shaped and are similar to those of American pondweed. Submersed leaves are arranged alternately with each leaf becoming extremely narrow as it nears the stem of the plant. Mineral deposits on its leaves often give large leaf pondweed a dark brown appearance.

## Naiad



Scientific name: *Najas minor* (brittle naiad)

Classification: Native to Indiana

Distribution: Common throughout the U.S.

**Description:** The leaves of naiad plants are usually widest at the base and gradually become thinner near the tip of the leaf. Plants are extremely leafy and appear bush-like when viewed from above the surface of the water. Many species of naiad are very common in this area. Plant structure often resembles chara, but the absence of calcium deposits on the surface of the plant help in identification. The leaves of brittle

naiad have multiple spines along the margins that are visible to the naked eye.

## Nitella



Scientific name: *Nitella sp.*

Classification: Native to Indiana

Distribution: Found worldwide, usually in hard water.

**Description:** Nitella is very similar to chara, and it is also an advanced form of algae. It has leaf-like projections that are whorled around the stem. It is often found growing in very thick patches, usually in shallow, clear water.

## Northern Milfoil



Scientific name: *Myriophyllum sibiricum*

Classification: Native to Indiana

Distribution: Found throughout the northern half of the U.S. and also in Europe and Western Asia

[www.io.uwinnipeg.ca](http://www.io.uwinnipeg.ca)

**Description:** Northern milfoil has submersed, feather-like, whorled leaves that closely resemble the leaves of Eurasian watermilfoil. Distinguishing the native northern milfoil from Eurasian watermilfoil can be difficult. The leaflet pairs of northern milfoil are generally fewer and more widely spaced than those of Eurasian milfoil. This plant is known to hybridize with Eurasian watermilfoil, and at times, chemical analysis is necessary to distinguish between the two plants.



## Sago Pondweed

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Scientific name: *Potamogeton pectinatus*

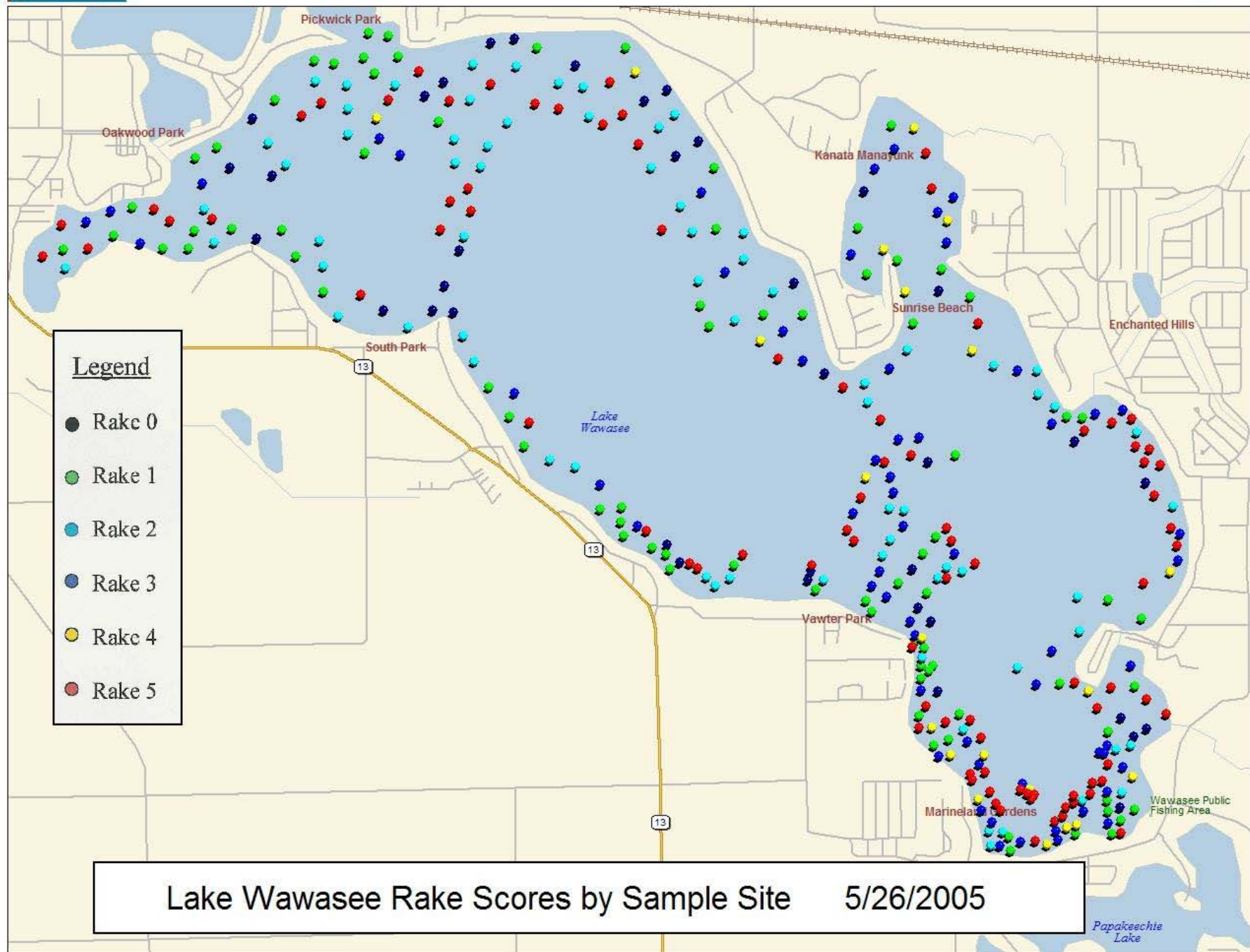
Classification: Native to Indiana

Distribution: Found throughout the U.S.,  
Common in the northern 2/3 of  
Indiana.

**Description:** Sago Pondweed has a bushy appearance with narrow, thread-like leaves that spread out to resemble a fan. Leaves are usually 1/16 of an inch wide and 1 to 6 inches long. Nutlets are formed on a string-like structure and protrude from the surface of the water. While sago pondweed can form dense beds, many times it is found in sparse, loosely distributed arrangements.

**Species Distribution Maps**  
**Data Sheets**

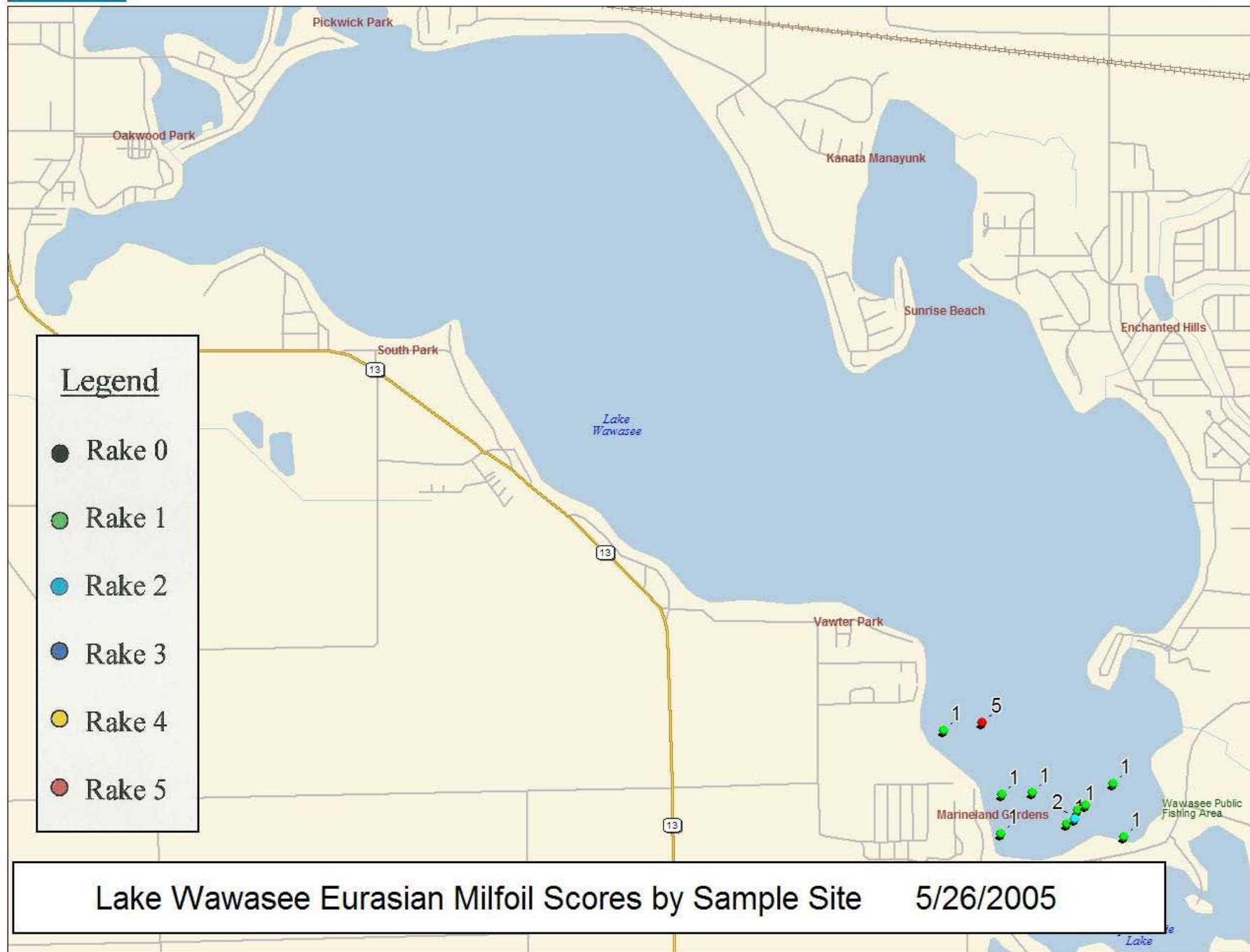




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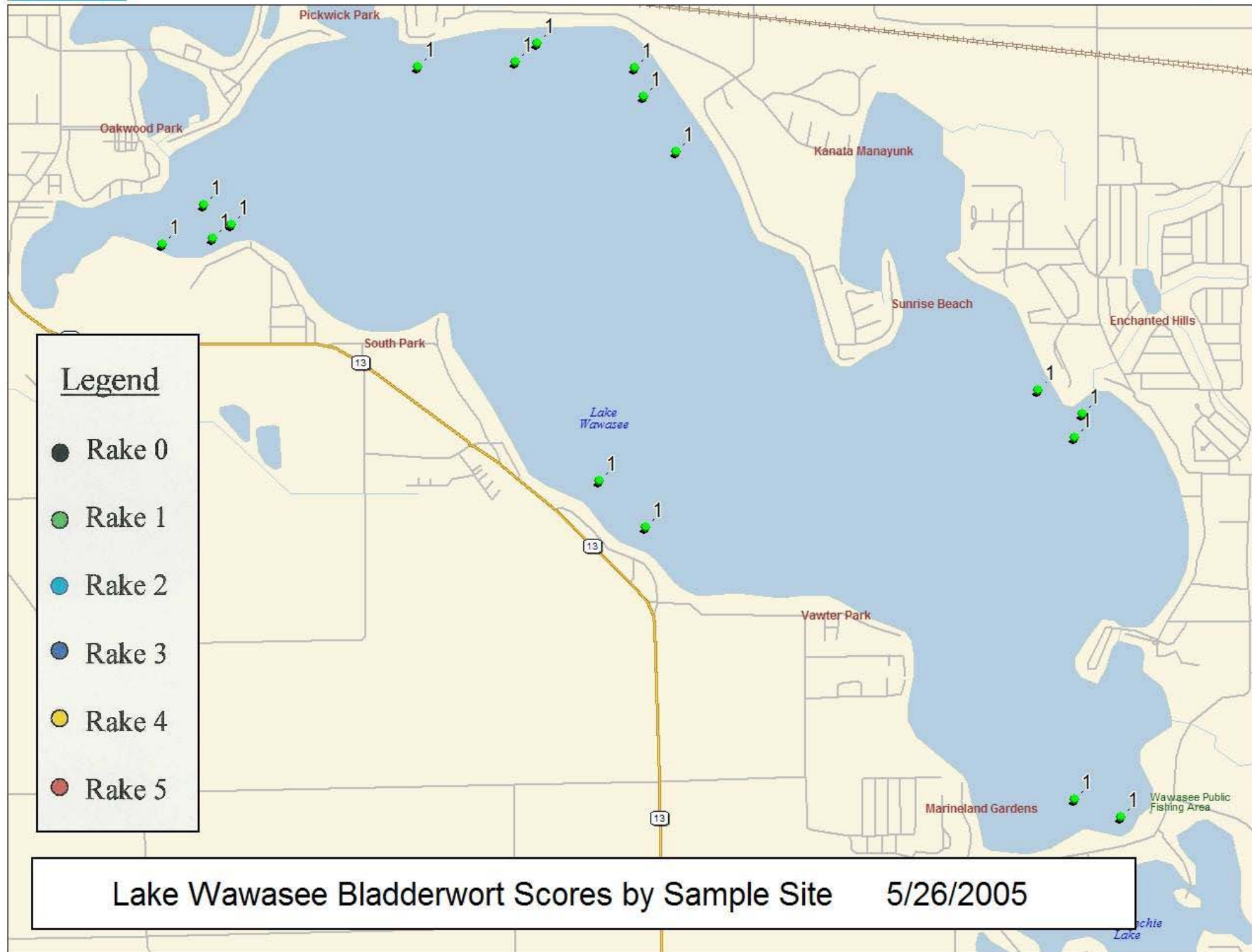
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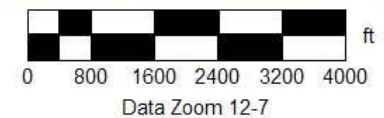
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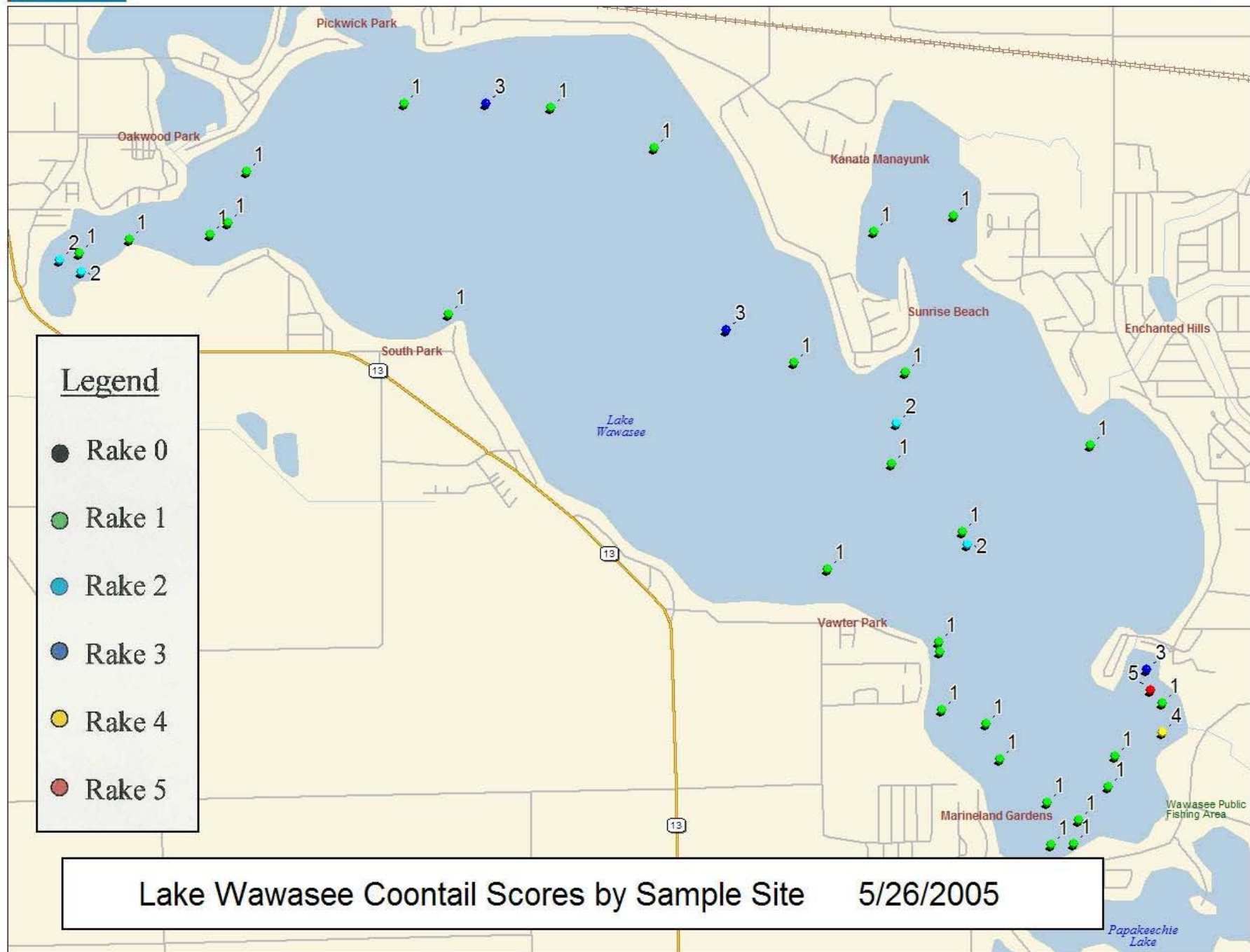
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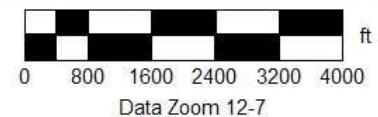


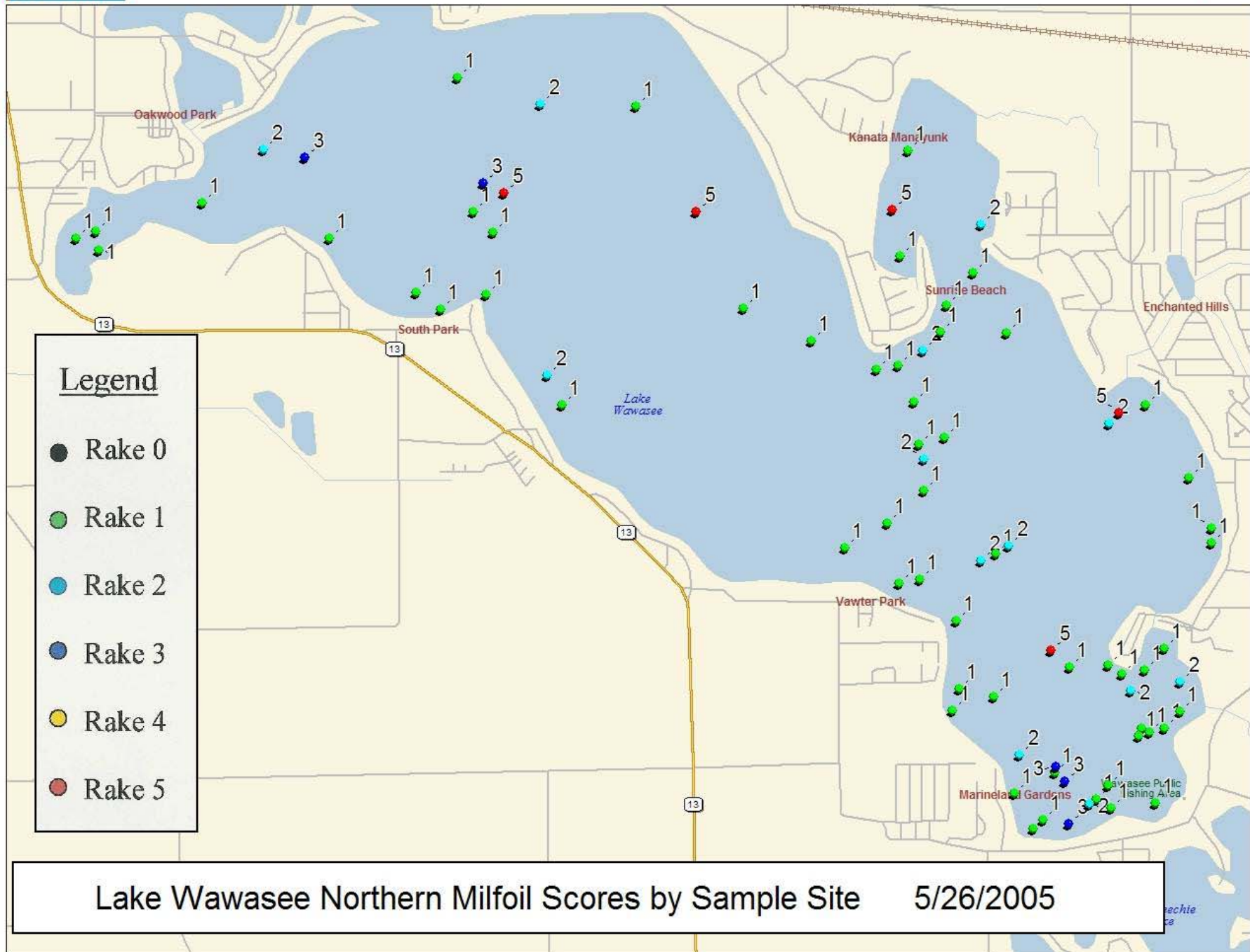


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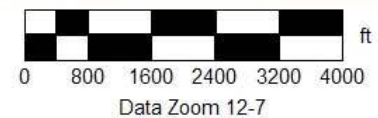


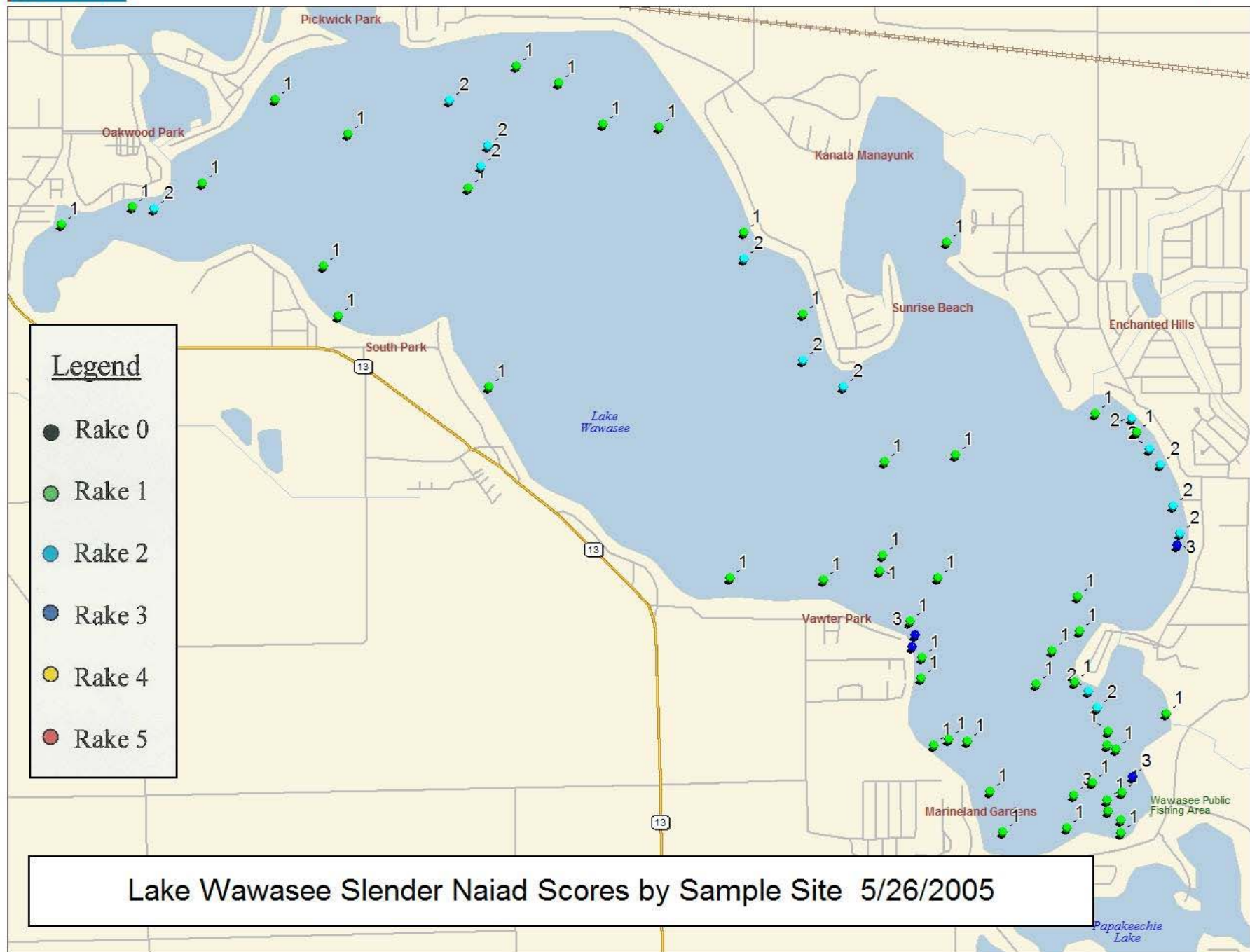


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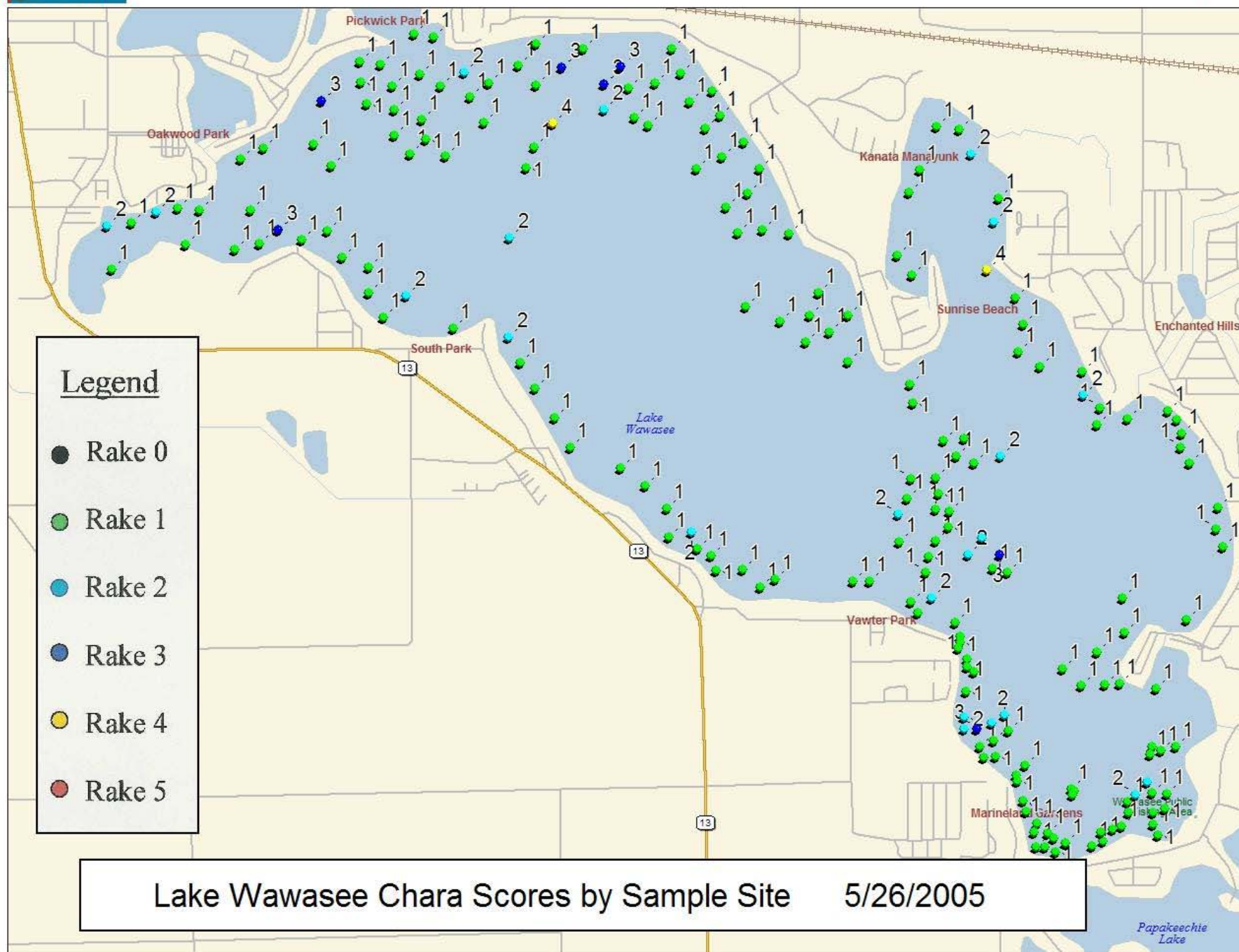


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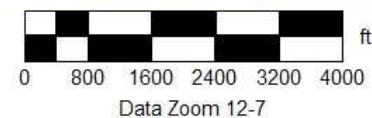




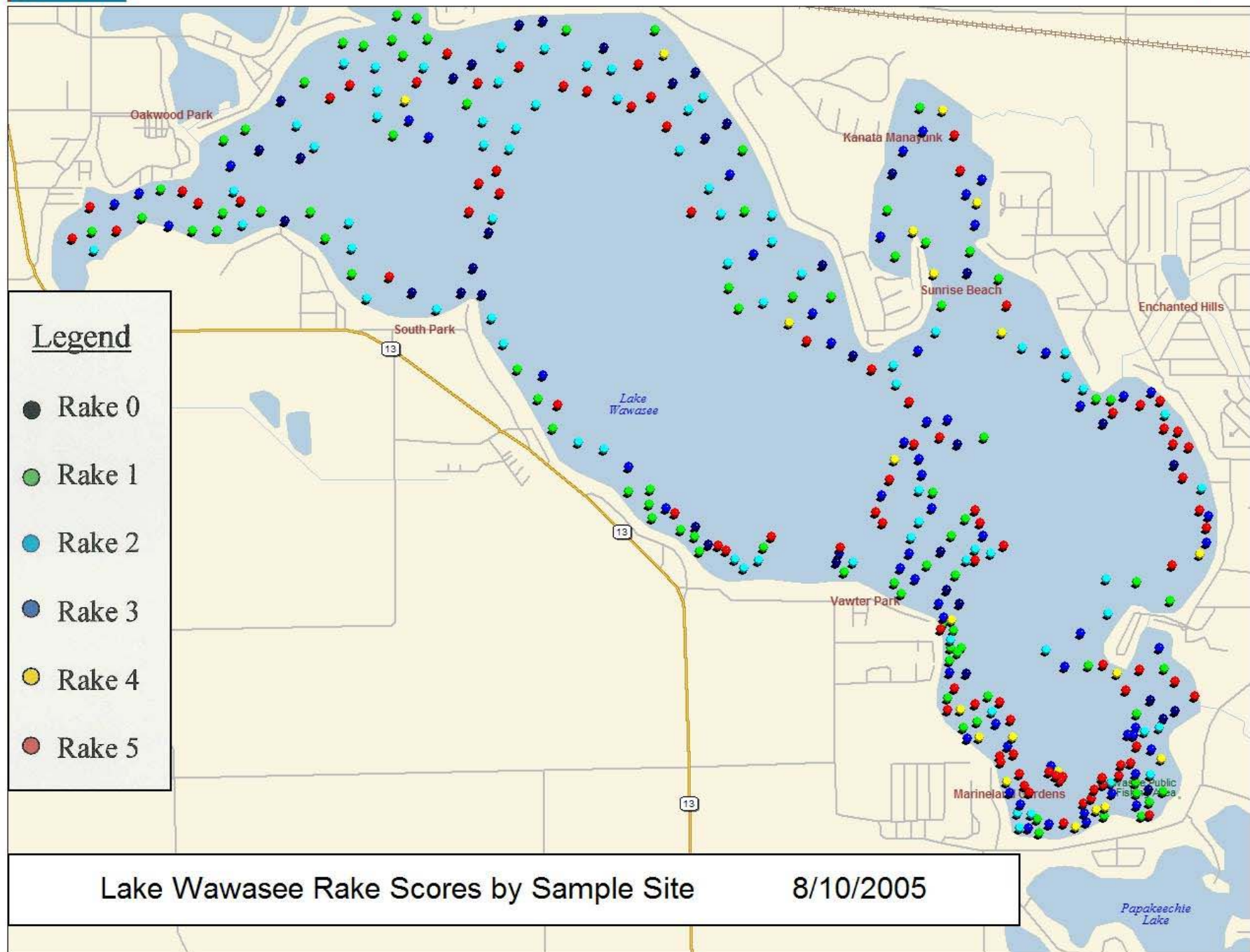
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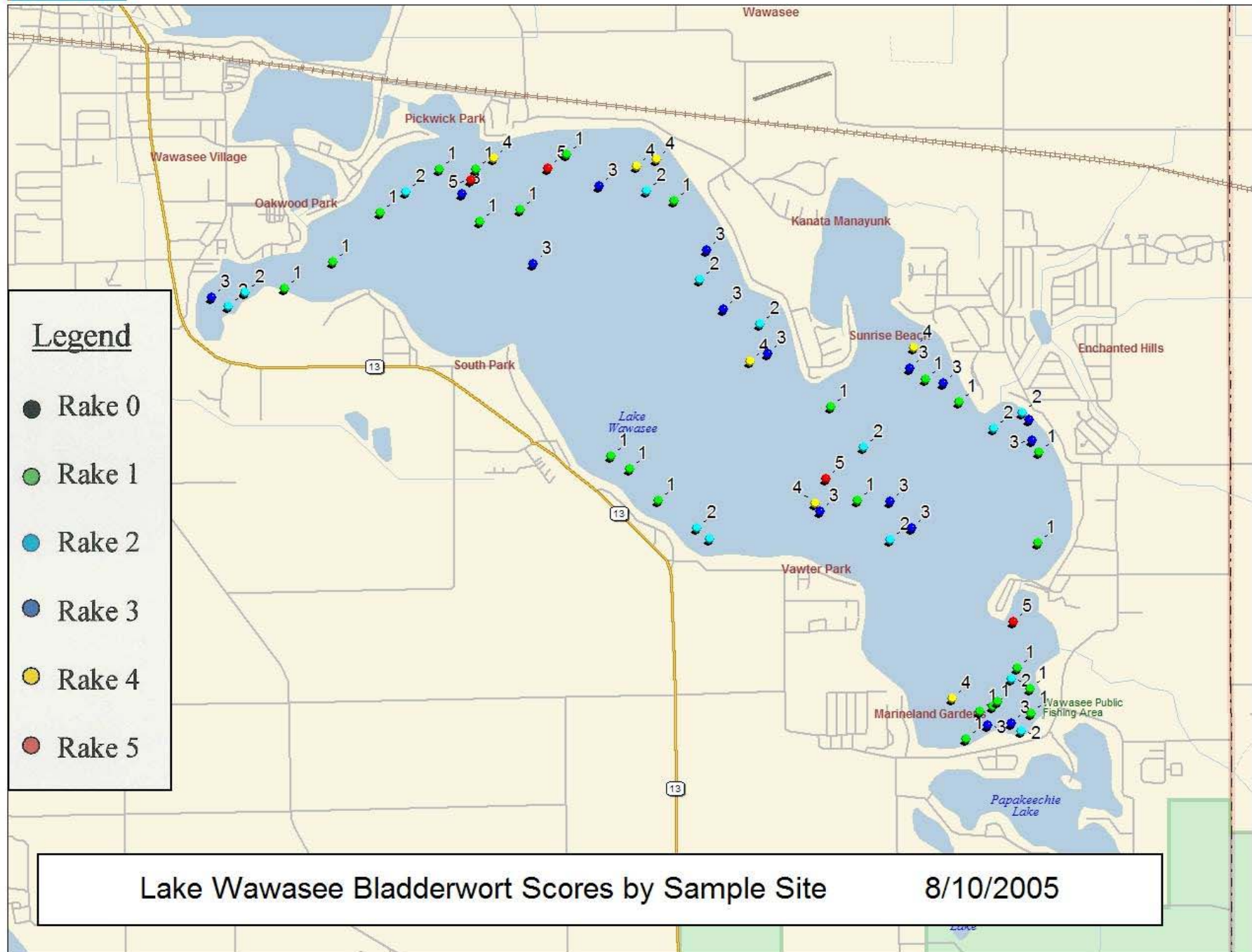




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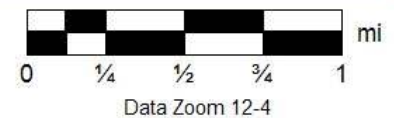
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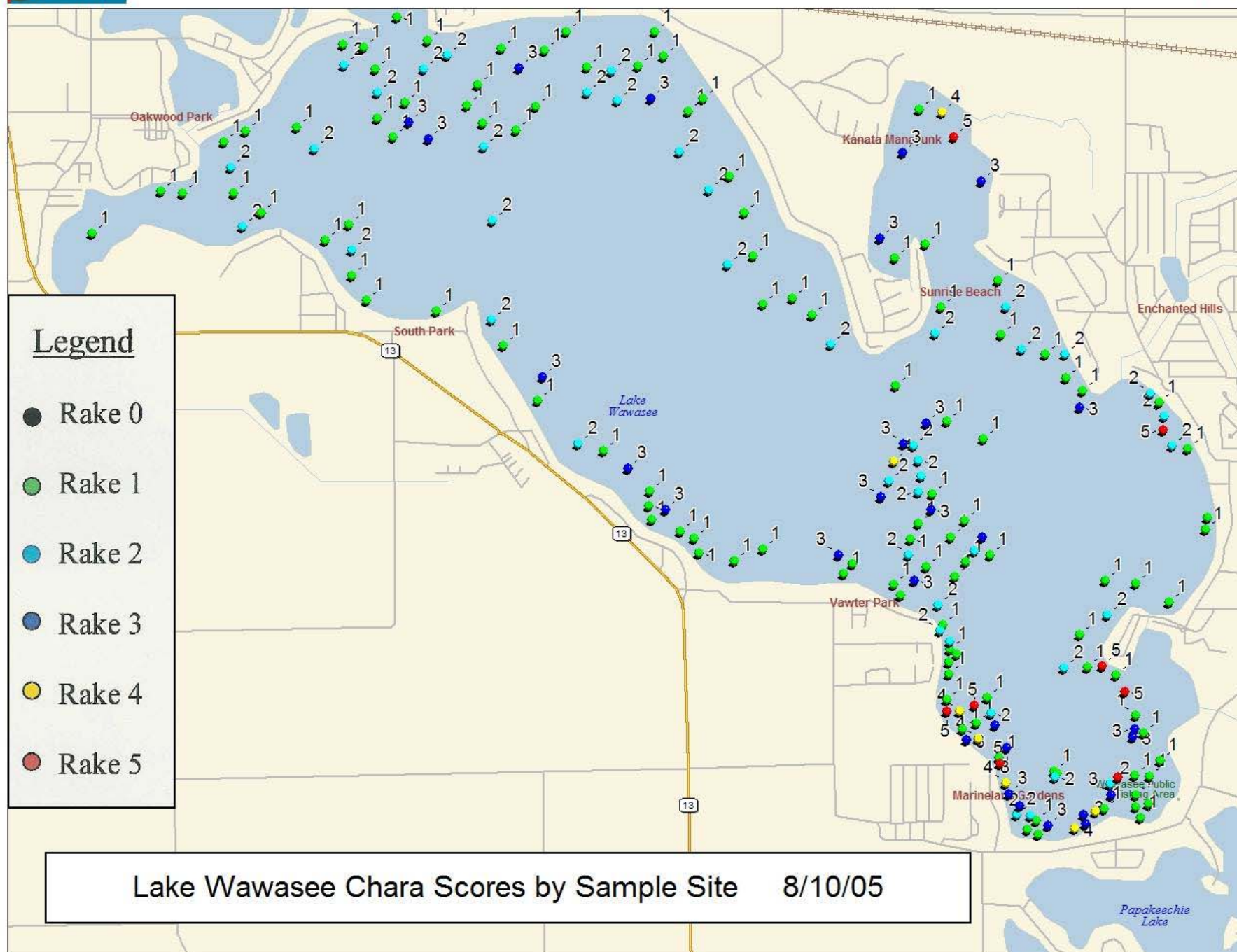
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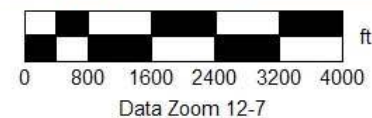


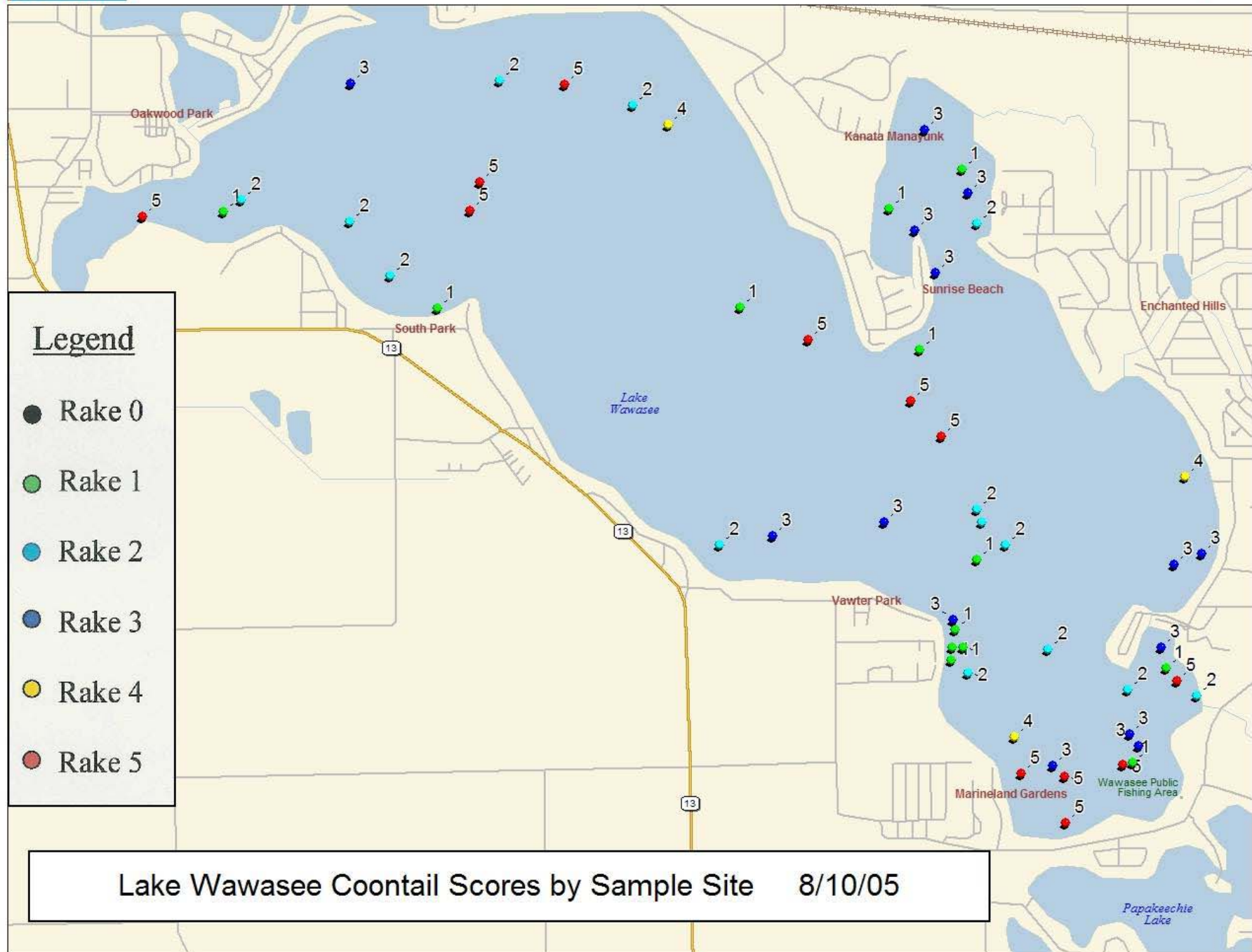


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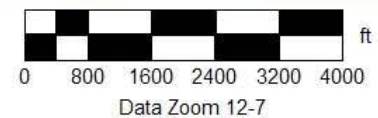




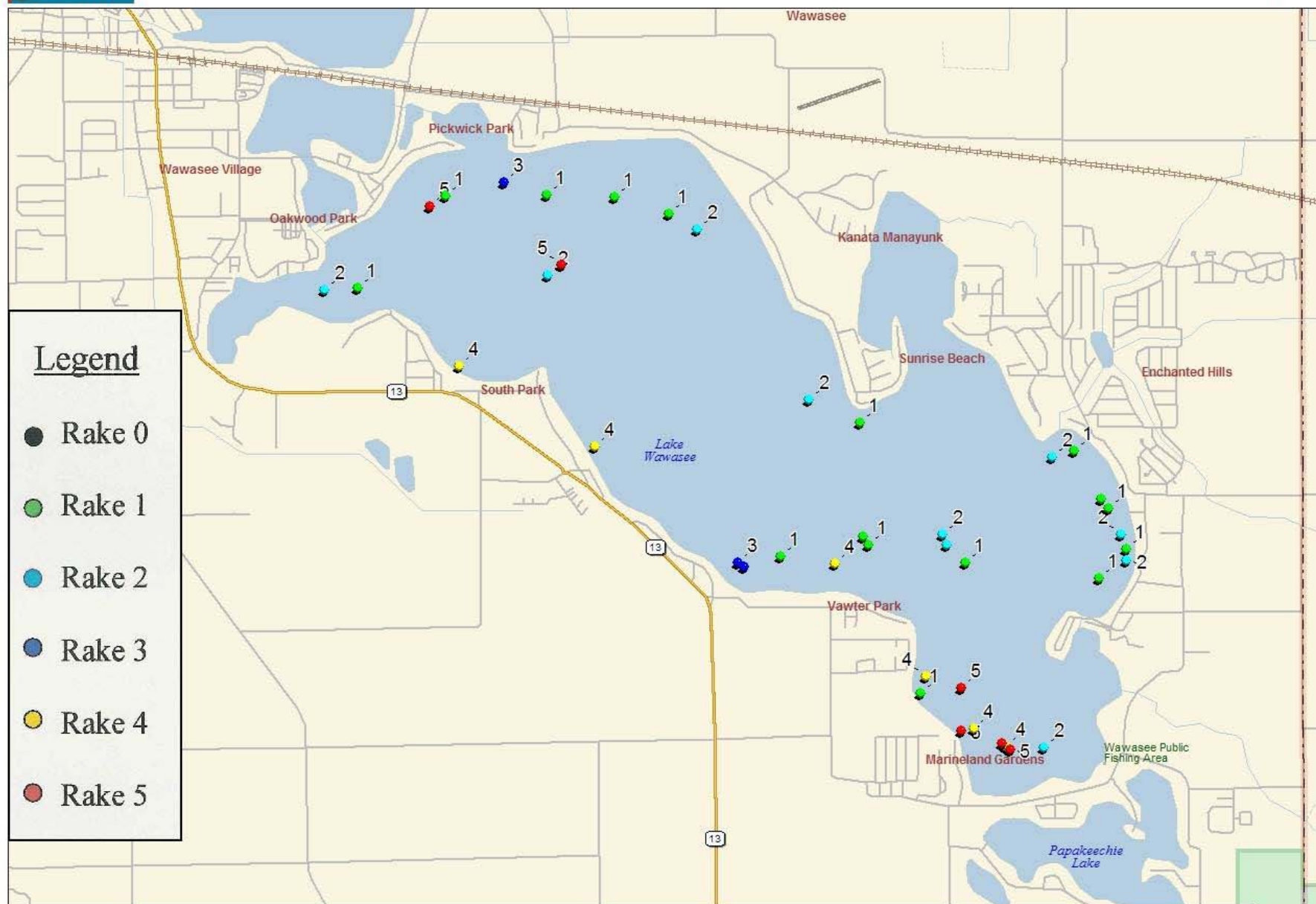
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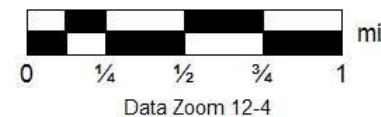
Lake Wawasee Eurasian Milfoil Scores by Sample Site

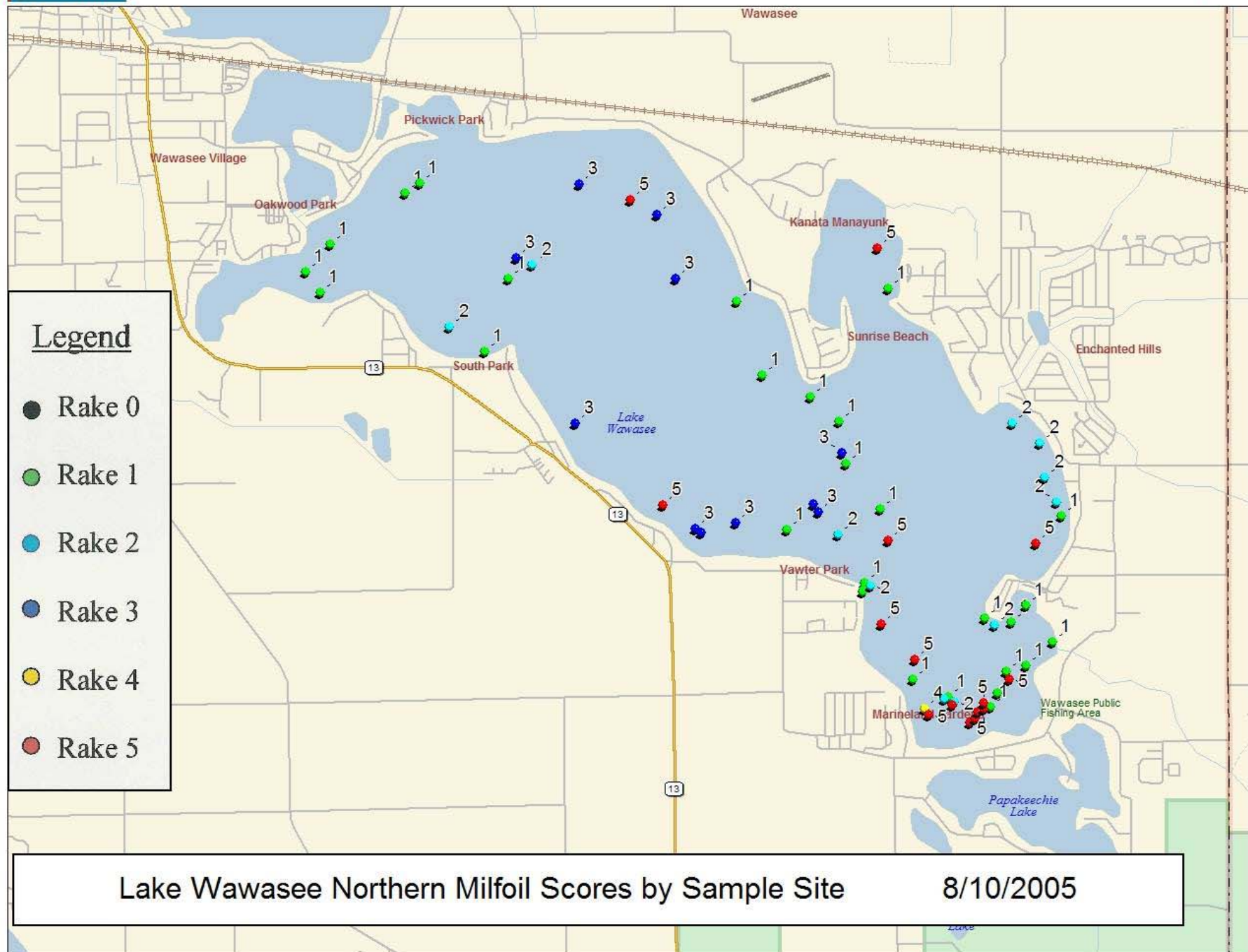
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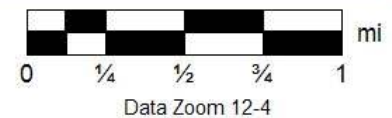




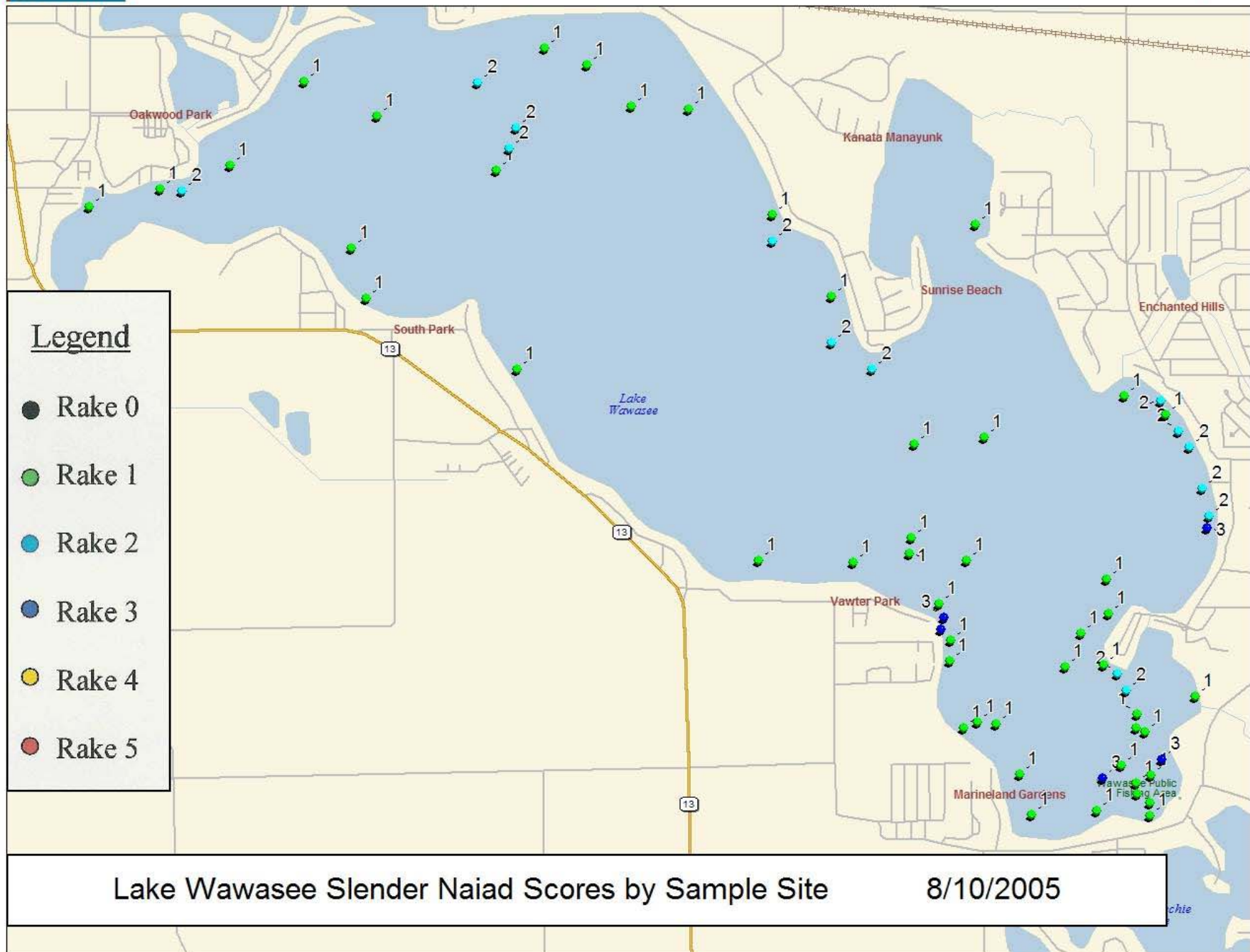
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